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The Effects of Burning Pasture and Woodland Vegetation

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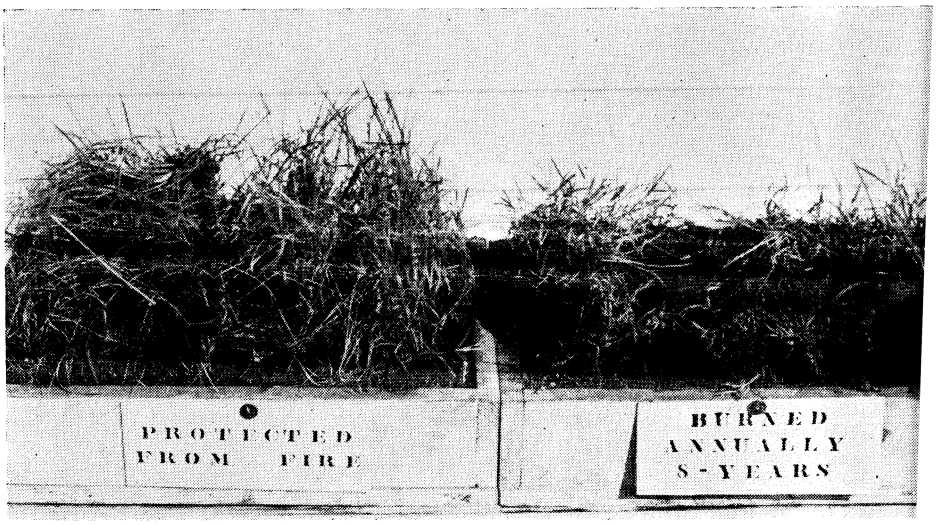
Effect of fall burning on native grass. **See page 5.**



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The Effects of Burning Pasture and Woodland Vegetation*

HARRY M. ELWELL, HARLEY A. DANIEL, and F. A. FENTON**

Nature's first line of defense against soil erosion is the vegetation which covers the earth. Wanton burning of this vegetation is one of the enemies in the battle to prevent soil, water, and fertility losses.

In times past, burning of pastures was commonly practiced. It removed old weeds and grass and thus made the early spring growth more easily available to livestock. It was also thought that burning destroyed harmful insects. Only recently has it been realized that whatever advantages burning may have, it also leaves the soil less fertile and more subject to erosion.

Two studies of the effects of burning vegetation have been made at the Red Plains Conservation Experiment Station located near Guthrie, Oklahoma. In one test, two small plots of scrub oak land were arranged so that soil and water losses from each could be measured. The woodland litter on one was burned in early spring each year, and the other plot was left undisturbed. In the other test, the quantity of native grass hay from a grazed pasture which had areas of burned and unburned land was compared with the quantity from other areas protected from both burning and grazing.

As a result of these tests, and of information from studies made elsewhere, it appears that burning makes the early spring growth of grass more available to animals and possibly makes it more palatable. This advantage is more than offset, however, by a reduction in both quantity and quality of forage produced over a period of years, by destruction of plant nutrients and organic matter, by increased losses of soil and water, and by damage to fence posts and other equipment.

Although no tests have been made of the effects of burning upon insect life, the detailed knowledge which is available about the way in which damaging insects hibernate and reproduce indicates that burning could have little effect upon them.

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EFFECT ON VEGETATION

In 1932, 110 acres of land, lying just east of the main farm of the Red Plains Conservation Experiment Station farm at Guthrie, was leased for experimental purposes. Part of this land was in native grass and scrub oak. The remainder, which had been abandoned from cultivation, was used from 1932 to 1938 for various kinds of plant cover studies (5).* In 1939 and 1940 the whole 110 acres was used for experimental grazing (6).

Beginning in 1932, a fire guard 40 feet wide was burned along the property lines and roadsides each fall as soon as there was danger from unrestricted burning. In 1939 and 1940, another area, which had been protected from grazing since 1930, was burned in the fall for experimental purposes. Thus, there were six different conditions available for study. A comparison of the amount of grass produced on the fire guards which were fall burned 8 years was made with that on the protected pasture under both grazed and ungrazed conditions. Another comparison of the grass on virgin land which was burned in the fall 2 years was made with that from an area that had been protected from both fire and grazing 11 years.

Quantity of Vegetation Reduced

Composite samples of the native grass from areas of equal size on each of the six locations were collected in October, 1940 and weighed. The results are given in Table I. On the location which had not been grazed for eight years, the area protected from fire produced 2,886 pounds of hay per acre and the fire guards 1,366 pounds. In other words, fall burning for eight years had reduced the hay production the last year by 1,520 pounds per acre, or 52 percent. On the location which had not been grazed for 11 years, the area protected from fire produced 3,907 pounds of hay per acre, while the area which was fall burned only two years produced 1,858 pounds, or 1,239 pounds less. Thus the total yield of hay was decreased 40 percent at this station by two years of fall burning.

These results seem to agree in general with tests made in Kansas by Aldous. Although he found that in the first year after burning (3) there was an increase in the early spring growth,** he reports (2, 3) a reduction in hay yields after several years of annual burning.

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* Figures in parentheses refer to "Literature Cited" at the end of this bulletin.

** On May 1, 20%, on May 15, 25%, and on July 1, 15% more grass on burned than on unburned areas.

Table I.—Effect of Annual Fall Burning on Yield of Native Grass; Red Plains Conservation Experiment Station, Guthrie, Okla.

Nature of Study	Hay per acre in 1940[1]	Loss of forage by burning
	(Pounds)	(Percent)
Ungrazed 8 years		
Unburned	2,886	
Burned 8 years	1,366	
Difference	1,520	52.67
Ungrazed 11 years		
Unburned	3,097	
Burned 2 years	1,858	
Difference	1,239	40.00
Grazed 2 years[2]		
Unburned	1,216	
Burned 8 years	496	
Difference	720	59.21

[1] Results from three uniform areas of each type; October, 1940.

[2] 110 acres of pasture were grazed by 14 yearling steers June 6 to October 3, 1939, and by 20 head from May 1 to October 1, 1940. (6)

Perennial Plants Destroyed

In a careful examination of the vegetation on the unburned as compared to the burned areas, perennial plants were found to predominate on the unburned land, while the plant cover where burning had occurred consisted largely of annuals. Apparently this condition had developed because the fire destroyed the seed of the perennial grasses and the old parent plants had died. The picture on the cover of this bulletin shows two samples of sod taken in 1940 from locations only 50 feet apart, and illustrates the difference between the vegetative cover on the burned and unburned areas.

In Alabama (10), the practice of burning pastures was found to destroy the seeds and young seedlings of desirable pasture plants and to allow undesirable plants and weeds to predominate. Where annual spring burnings occurred, it was also found impossible to maintain stands of carpet grass, Dallis grass, lespedeza, and hop clover.

Stock May Prefer Burned Areas

One of the common reasons offered for burning pastures is to destroy the old dead plants and weeds so that the grass will be more palatable to livestock, and there seems to be some

evidence that cattle do prefer a previously burned area if given their choice. The fire guards that were burned in the fall for 8 years and grazed in 1939 and 1940 had lost 59 percent of their vegetation by October, 1940 (table I), while an area which had not been grazed lost only 52 percent.

In California, experiment station workers investigating the effects of burning on range management reported that "At least during the first season following a fire, stock generally prefer the vegetation on a burned-over area" (7) and that cattle, sheep and deer utilized the burned range land to a greater extent than they did the unburned areas (8). They believed that this was due to a higher phosphorus content of the vegetation following burning (7).

Regardless of the preference of livestock for burned-over pasture, whether due to differences in chemical composition of the grass or to absence of old dead plants, this preference does not seem to warrant burning with its attendant reduction of total vegetation and increase of soil and water losses.

MOWING CAN REPLACE BURNING

So far as removal of dead plants and weeds is concerned, satisfactory results have been obtained at the Guthrie Station during the past five years by mowing the weeds and dead grass about the middle of May. In Kansas, this practice has been recommended by Aldous (1) for controlling weeds and brush in pastures. He reports that mowing was more effective when it was done at the low point of the organic food reserves, which condition, according to his findings, apparently appears during the first part of May for a large proportion of the common weeds. The Agricultural Adjustment Administration has approved the payment of 25 cents per acre for mowing of noxious plants for range and pasture management in 1940 (11). The residue may be left on the ground in pastures, where it aids in the formation of a protective covering for the soil.

Mowing about the middle of May has also given satisfactory results on hay meadows in removing the second growth of grass that appears in the fall after the hay has been harvested. Removal of this second growth is the most common reason offered for burning meadows. Although in pastures the residue from May mowing may be left on the ground, in meadows it probably needs to be removed. By this time, however, most of the seed has dropped on the soil and is saved for replacing plants that die.

The clippings that are removed from May-mowed meadows may be used advantageously for mulching material on eroded land. Figure 1 shows such material in use in a gully on the Guthrie Station Farm in 1939. The residue from a mulch catches the soil and creates favorable conditions for plant development. It is true that this plan of management requires labor, but it can be done largely at a time when the fields are too wet to cultivate; or, if weed growth is not a problem, pastures and meadows may be mowed in the winter and early spring. The saving in hay yield and plant nutrients alone should more than pay for the expense involved, not to mention the saving in soil on both meadow and eroded land.

EFFECT ON SOIL FERTILITY

Burning reduces the productiveness of pasture soil by rapidly oxidizing the partially decomposed organic matter and placing the minerals contained in the vegetation in a form which may be readily removed by leaching and erosion. Fire also releases into the air the nitrogen contained in the vegetation which is burned, makes conditions unfavorable for soil-forming organisms, and increases flood hazards and erosion.

Figure 1. Residue of plant material being used advantageously in gullies on the east farm at the Guthrie, Okla., Station.

Nitrogen Is Lost

The smoke from burning grassland takes into the air the nitrogen in the grass (figure 2)—nitrogen which the grass took from the soil. The exact quantity of nitrogen thus lost by the soil when a particular area burns is hard to calculate; it varies with the amount of vegetation, the intensity of the fire, and the kind of vegetation. To get a general idea, however, the forage production shown in Table I was used as a basis of calculation. A previous analysis of 368 samples of native grass from 52 Oklahoma counties (4) had shown the average nitrogen content to be 0.868 percent. On this basis, the 1,366 pounds of hay which was burned in the eighth year of the eight years of annual burning contained 11.9 pounds of nitrogen.

Figure 2. Careless roadside fires destroy vegetation and other resources, and nitrogen goes up in smoke.

If the protected portion of the areas should actually be burned, the loss would be even higher. The 2,886 pounds of hay on an acre of the land which went ungrazed for eight years would contain 25.05 pounds of nitrogen, and the 3,097 pounds on the area ungrazed for eleven years would contain 26.88 pounds of nitrogen. These figures show the extent to which a loss of nitrogen may be caused by grass fires.

Organic Matter Destroyed

Besides the losses in hay or pasture and in nitrogen, burning destroys the partly decomposed plant material and organic matter that protects plant roots, holds water, and improves the physical condition of the soil (See picture on cover). Underneath the grass on land which is protected from fire is a dense layer of litter. This litter forms a protective carpet, readily permeable to water and at the same time cushioning the soil against the impact of falling raindrops and compaction due to footsteps of livestock. The residue of dead grass also retards evaporation (9) and gives protection from temperature extremes (2) and thus makes conditions more favorable for the development of worms, beneficial insects, and micro-organisms within the soil. This material decays slowly, releasing to the soil a part of the essential elements which it contains and leaving a humified residue which absorbs water and improves the physical condition of the soil.

Other important forms of organic material often overlooked are the lower forms of plants such as lichens, algae, and moss. These small plants occur on eroded land retired from cultivation and on virgin soil which is not completely covered by the larger forms of vegetation. The crusted forms of these little plants (Figure 3) bind the soil particles together, prevent further erosion, and assist in retaining water which is essential for the growth of higher forms of plants. Destruction by fire of these lichens, algae and moss may often be a serious hazard in securing a stand of useable grasses.

Soil and Water Loss Increased

The effect of burning woodland on soil and water losses has been studied on two of the control plots at the Red Plains Conservation Experiment Station since 1931. These areas are located on uniform Stephensville soil that is covered by scrubby oak. The plots are each 72.6 feet long and 6 feet wide and separated by metal dividers. The total run-off from each was caught at the lower end of the plot in a concrete basin constructed to measure the total volume of water. All forest litter and vegetation was destroyed by burning every year in early spring on one plot and left undisturbed on the other. The results are recorded in Table II.

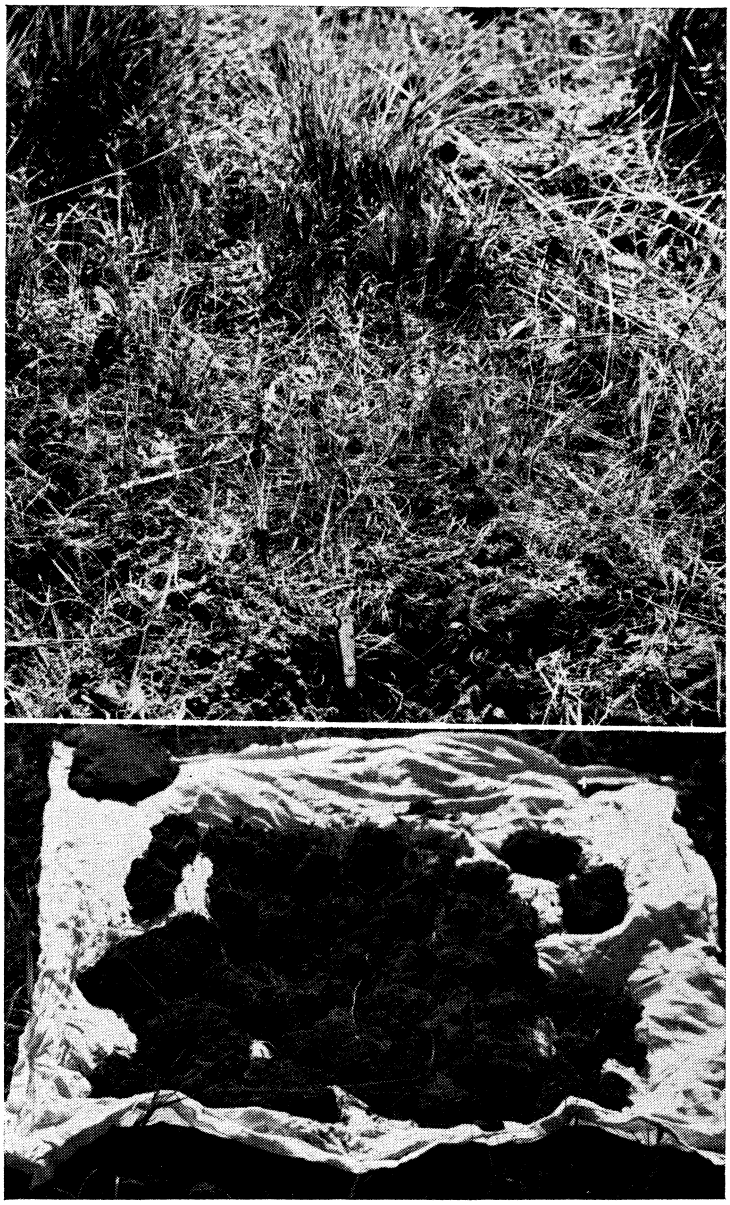

Figure 3. Lichens, algae and moss provide protection for the soil and for other higher forms of plants.

Table II. Soil and water losses from burned and unburned woodland at the Guthrie Station, 1931-39.[1]

Nature of Study	No. of rains	RAINFALL INCHES			SOIL LOSS PER ACRE TONS			RUN-OFF IN PERCENT OF RAINFALL		
		Low	Average	High	Low	Average	High	Low	Average	High
Annual										
Undisturbed woods					0.00	0.009	0.03	0.00	0.13	0.43
Burned woods[3]	55	21.52	30.10	37.73	.00	.108	39	.10	4.00	8.75
Maximum rains[2]										
Undisturbed woods					.00	.000	.01	.00	.50	2.09
Burned woods[3]	17	1.23	2.59	5.85	.00	.020	.17	.00	11.81	48.12
Moderate rains[2]										
Undisturbed woods					.00	.000	.00	.00	.15	.36
Burned woods[3]	22	.62	1.97	4.16	.00	.010	.09	.00	6.65	51.11
Minor rains[2]										
Undisturbed woods					.00	.000	.00	.00	.11	.27
Burned woods[3]	19	.29	.91	4.10	.00	.000	.01	.00	1.21	22.70

[1] Plots were 1/100 acre in size or 6 feet wide and 72.6 feet long on Stephensville fine sandy loam, with a land slope of 5.17%.
[2] The rains are grouped into maximum, moderate, and minor rains on the basis of 30-minute intensities of 2 or more inches, 1 to 2 inches, and 0.5 to 1 inch per hour.
[3] Burned in early spring.

Average annual soil and water losses from the burned plot were 12 and 31 times more, respectively, than from the undisturbed woodland. The highest water loss from a single rain for the burned woodland was 51.11% and for the undisturbed woodland 2.09%. The soil loss was 0.17 and 0.01 tons per acre, respectively. The layer of residue accumulated on the unburned woodland formed a protective cover of spongy material that reduced the velocity of flow, gave the water a chance to penetrate the soil, and thereby delayed run-off, reduced flood hazards, and saved soil.

OTHER LOSSES ALSO INVOLVED

Besides reducing hay and pasture yields, lowering fertility, and increasing soil and water losses, burning has other bad effects. Such farm resources as crops, forestry, fences, farm equipment, and buildings are often destroyed by fire which get out of control. Even with careful burning, the food and homes of wildlife are destroyed; and this wildlife is valuable to mankind. Rabbits, squirrels, quail, and fur-bearing animals provide food, recreation and sometimes income for farmers. The indirect effect of burning in causing flood losses is also to be considered.

SUMMARY OF EFFECTS ON SOIL

In summarizing the effects upon the soil of annual burning of pastures, it can be said that this practice (a) causes a loss of nitrogen, (b) destroys organic matter and (c) increases both soil and water losses. This agrees with results of tests in other states. In Alabama, annual spring burnings were found to reduce the organic matter and nitrogen content of the soil (10); and in Florida there was a loss of soil fertility and an increase in evaporation due to fire destroying the grass mulch and residue (9).

EFFECT OF BURNING ON INJURIOUS INSECTS

One of the reasons given for burning is that it controls injurious insects which hibernate in vegetation. Many of the most injurious, however, in Oklahoma pass the winter in the soil where burning cannot harm them. Included in this list are grasshoppers, the corn ear-worm or cotton bollworm, various species of white grubs which attack corn and wheat, wireworms, blister beetles, the garden webworm, and false wireworms.

Two of the most injurious insects, the cotton leafworm and the fall armyworm, do not survive Oklahoma winters but migrate into the state each year. Doubtless others such as the corn earworm, the true armyworm and the cotton boll weevil, which suvive the winters in small numbers, are also migratory.

Many destructive insects hibernate in crop land which is non-burnable. This is true for the Hessian fly and also for the clover leaf weevil and others which affect alfalfa. The corn bill bug, the southern cornstalk borer and the southwestern corn borer spend the winter in corn stubble.

The cotton fleahopper passes the winter in the egg stage in various large stemmed weeds, such as the crotons. The weeds flourish in overgrazed pastures where continuous burning might make conditions more favorable for weed growth.

The cotton boll weevil survives the winter in very small numbers except in southeastern Oklahoma. Even here the percentage of survival is so small that it is extremely doubtful if burning would accomplish much good.

Promiscuous burning is no longer recommended for chinch bug control. The bugs pass the winter in bunch grasses or other grasses with a bunch habit of growth, but usually along the margins of sorghum or late corn fields. Burning entire pastures or wooodlands, by reason of its destructive effect on the soil, would cause far more harm than good in this respect; and such burning for the control of this bug is not recommended by this Station.

Only a very small percentage of insects are injurious. It seems reasonable to believe that promiscuous burning would destroy some insects that are beneficial either as pollenizers of plants or because they prey upon or parasitize injurious forms.

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