## Alfalfa as a Range Legume[1]

**Arthur D. Miles**[2]
*Rancher, Livingston, Montana*

### Highlight

**Alfalfa invades spring grazed range. Plowing range and sowing alfalfa and orchardgrass demonstrates alfalfa's ability to produce forage and fertility. Several methods of establishing alfalfa on the range are described. Alfalfa has been found to be more adapted to the dryer sites. It supplies fertility, changes plant composition, and greatly increases carrying capacity. Alfalfa thrives on close spring grazing, it draws on winter accumulated moisture, raises humidity, and catches drifting snow. In one study, alfalfa has stimulated native grass cover to the exclusion of big sagebrush.**

Alfalfa (*Medicago sativa*) has been found ecizing—establishing colonies—on spring-grazed range on the ranch here in south central Montana, elevation 5,000 ft, annual precipitation around 20 inches. The fact that alfalfa will persist, among the native grasses was of considerable significance since it has the ability to fix atmosphere nitrogen into useable nitrates.

Many years of alfalfa growing studies have been carried out at the ranch to find out more about growing and grazing it. Partial answers have been found to such questions as: How can alfalfa be established among the bunches of Idaho fescue (*Festuca idahoensis*) and bluebunch wheatgrass (*Agronpyron spicatum*) on the range. Will the large amount of nitrogen fixed by the alfalfa create a change in the range composition? Will introducing alfalfa create a bloat problem? How much grazing will alfalfa stand and still persist and fix large amounts of atmospheric nitrogen?

A plant that stays as green and palatable as does alfalfa during the July–August summer drought periods stands little chance of survival on summer grazed ranges (Boulton, 1962). By regulating the grazing to favor the alfalfa, this plant has been found to grow as well among the range grasses as in the adjacent hay fields. On sites that appear dry and infertile, alfalfa produces a lush, sumptious growth.

*Plow Range.*—It was found that the native grasses could be plowed out and a pasture of alfalfa and orchard grass (*Dactylis glomerata*) established with far greater carrying capacity and weight gains on a sustained production basis than does the original fescue and wheatgrass. It is realized that the alfalfa not only provides nitrogen, causing the orchardgrass to grow thick-leaved and dark green, but that the long roots of the alfalfa reach into supplies of potash and phosphate. The orchardgrass roots deeply and has a bunch habit of growth that is compatible to the alfalfa. During the high humidity spring-grazing period of May and June, the orchard grass-alfalfa produces a tremendous amount of forage in two rotation grazings without irrigation or fertilization. The first grazing is done when the orchardgrass is 18 inches high, the second when orchardgrass and alfalfa 14 inches. The third growth is allowed to go ungrazed.

#### Establishing

Alfalfa has been successfully established on Idaho fescue, bluebunch wheatgrass, western wheatgrass (*Agropyron smithii*), junegrass (*Koeleria cristata*) range by a combination of surface tillage and close grazing. It is necessary to provide enough moisture, fertility, and space for the alfalfa seedling to root deeply enough to survive the summer drought period.

In the first test area, about half the existing grasses were killed by surface tillage. The tillage was started by a chisel taking out strips of grasses, going one direction, then the other. This was followed by disk and spring-tooth harrow to take out more grass and to shake the dirt out of the clods that had been torn loose. The final operation was to level with a peg tooth harrow. The alfalfa was sown in 18-inch rows across the prevailing wind with a single-disc grain drill with grass seeding attachment.

In the successful alfalfa establishment among the native grasses and all subsequent trials, close grazing before and during establishment have been found essential. Any cultivation or fertilization used to establish the alfalfa stimulates the growth of the remaining grasses. Keeping the grasses grazed closely during the period of establishment enables the alfalfa to root sufficiently to survive. Once the alfalfa makes it through its first summer it is able to compete successfully with the grasses.

In order to simplify and reduce the cost of establishment, a cultivating range drill has been used (Fig. 1). The drill drops the seed, 40 lb/acre of 11-48-0 fertilizer, and 40 lb lime, along with inoculant and heptaclor insecticide into a furrow removed by the drill. The phosphate overcomes surface deficiency. The lime neutralizes the acid effect of the phosphate that tends to kill the inoculant bacteria. The insecticide keeps the alfalfa weevil from

FIG. 1. Cultivating range-drill used for establishing alfalfa in sod.

[1] Submitted June 25, 1968; accepted for publication November 8, 1968.

[2] Editor's Note.—In correspondence, Arthur Miles has written in part: "I've considered myself as liaison—breaking down research information into practical application. However, I get curious about certain aspects that I can find no research on . . . . This alfalfa thing is extremely fascinating—particularly when you get so much grass that you have difficulty acquiring sufficient cattle to graze it. But I have no way to come up with scientific proof of what takes place. By 'mental manipulations' I assume that the same thing takes place here as it does under similar situations in other places that I have read reports of. . . . It has been frequently said: 'Suitable range legumes haven't been found'. Seems it should read: 'Suitable range legumes for existing management systems haven't been found.' "—R.S.C.

FIG. 2. Sagebrush is mowed, allowed to dry, then burned to prepare seedbed for sowing alfalfa.

consuming the cotyledons and killing the seedlings. With a combination of grazing and favorable moisture conditions, the alfalfa becomes established.

A particular low-cost and successful seeding was made with close grazing and broadcast seed. In April, following the dry season and close grazing of 1961, seed was broadcast with an electric truck-mounted seeder into frost cracks that the freezing and thawing had produced. The following rains sloughed the ground over the seed and a successful stand of alfalfa was obtained. Alfalfa seeds don't establish plants where they aren't covered and don't have something to grow against to push the root into the ground. Broadcast seedings have failed to establish plants after burning or close grazing where no frost cracks were formed or where wind or rain had filled the cracks.

*Sagebrush Seedbed.*—A firm, fertile, weedfree seedbed is prepared on sagebrush (*Artemesia tridenta*) ground by mowing and burning the mowed sagebrush (Fig. 2). The mowing and burning cost two dollars per acre. Burning of the mowed sagebrush and accumulated duff releases base minerals, potash, phosphate, and calcium beneficial to alfalfa establishment (Fig. 3).

FIG. 3. Established alfalfa, second year after seeding in mowed and burned sagebrush area.

Sowing in mowed, but unburned sagebrush has been only partially successful. What seeds did sprout readily established plants, but apparently the duff and mowed materials didn't allow sufficient soaking of the alfalfa seed for it to sprout.

Fair stands of alfalfa have been obtained by broadcasting seed in the spring or fall-burned standing sagebrush. The success of this procedure is dependent on whether there are satisfactory frost cracks for the seed to roll into. Close grazing during seedling establishment is a factor in establishment. This type of establishment is carried out on ground too steep or rocky to be sown with a drill. Broadcasting provides thinner stands and is more expensive to carry out.

*Edaphic Considerations.*—Alfalfa needs well-drained soil. It doesn't survive on poorly-drained or high water-table land. Since sagebrush prefers good drainage and aeration, it would appear that sagebrush sites would be ideal for alfalfa. However, alfalfa doesn't survive in the higher elevations and north-facing slopes. A shortage of calcium and other elements as magnesium, sulfur, potash, maybe even moylybdinum or boron, may be the reason the alfalfa does poorly on these soils.

Alfalfa thrives on the dryer, more wind swept, lower elevation (4800 ft) sites. On these dryer, high-lime sites, the alfalfa readily sets seed and seedlings become established. On sites with greater moisture, alfalfa stands thin out with the root-feeding of the pocket gophers (*Thomomys* spp.), greater competition from sod grasses, and other factors as fertility and aeration.

*Inoculation.*—Lack of inoculation with nitrogen-fixing bacteria has been recognized as a factor in obtaining establishment on soils that haven't previously grown alfalfa or sweet clover (*Melilotus officianalis*). Base fertility elements as calcium and magnesium, are considered essential to making conditions favorable to the bacteria. It has been found necessary to mix ground limestone with phosphate starting fertilizer to keep the inoculent alive. Inoculent bacteria have a low tolerance of low pH.

*Fertility Effect.*—The fertility supplied with alfalfa is not too much different from fertility supplied with commercial fertilizer. The amount of nitrogen fixed and provided by the alfalfa can be figured by the ⅔ rule (Ellison, 1958). The amount of nitrogen contained in the legume top growth is approximately ⅔ the amount fixed, the rest occurring in the roots. A one-ton/acre yield of alfalfa contains 50 lb nitrogen, indicating that 75 lb has been fixed. The long roots of the alfalfa find sufficient phosphate and potash to balance out the nitrogen fixed (Pieters, 1927). Consequently, the alfalfa adds nitrogen and phosphate to the community.

Keeping the cattle continually on the grass areas conserves the manure and urine and causes a rapid build-up of fertility and organic matter (Morrison, 1956; Davis, 1960). Eliminating the brush and trees where the cattle tend to collect has been a factor in saving the manure fertility. With the rapid increase in fertility provided by a good cover of alfalfa, the biotic-climax dominants will change from plants that get by with low fertility to those that respond to it. Western wheatgrass responds more to the fertility. Idaho fescue responds to a build-up of soil organic matter.

The range can be changed from Kentucky bluegrass (*Poa pratensis*) and weeds, to Idaho fescue with the fertility build up of feeding alfalfa hay to sheep on the range. After eight winters of feeding sheep alfalfa hay on the range a marked increase in the amount of Idaho fescue was observed. It was considered that the alfalfa manure provided 100 lb of nitrogen annually.

It is desirable to allow the alfalfa-sown range to move up rapidly in condition to prevent an invasion of annual weeds as cheatgrass brome (*Bromus tectorum*). Also, a thick cover of grass helps prevent bloat by keeping the cover from being conspicuously alfalfa.

### Grazing Management

A plan of spring grazing of alfalfa-sown range during May and June has worked well. High levels of nitrogen fertilization are obtained from regrowth of alfalfa from the year before and from the growth during grazing (Pieters, 1927). The high level of nitrogen offsets the luxury consumption of nitrogen that goes with early grazing (Allison, 1957). Both the alfalfa and the grasses regain their vigor during the grazing free summer and fall.

Just what kind of successful grazing management will be worked out for summer-grazed alfalfa-sown ranges remains to be determined. Low-growing root-sprouting alfalfas as the variety Nomad can stand longer periods of close summer grazing than the upright alfalfas. Continual close summer grazing will kill the alfalfa.

*Irrigation Effect.*—Not only does alfalfa fix large amounts of nitrogen, draw on the lower soil horizons for phosphate and potash, it also in effect, irrigates itself. Drawing on fall, winter, and spring accumulated moisture in many feet of soil, it raises the humidity in the plant community (Daubenmire, 1947). Its tall growth stills the wind and the large amount of moisture that it transpires changes the growing conditions of associated grasses.

The moisture accumulation effect during the high humidity fall, spring, and winter accumulation period and the low humidity during summer is quite suitable to alfalfa growth. It is essential that the alfalfa draw out the moisture during the dry July and August, thereby effecting gas exchange (Freymon and Brink, 1967). As the dormant-season moisture accumulates, the carbon dioxide is forced out of the soil and the reservoir is filled for the next seasons growth. Without the drying effect of August, conditions in the lower soil horizons would become unsuitable for the long-rooted legumes.

The stiff alfalfa stubble of the regrowth after spring grazing holds the drifting snows of winter, providing more moisture for the lower soil. With each chinook of winter, the alfalfa stems are ready to catch the snow of subsequent storms to keep it from blowing over into the gullies and draws.

Alfalfa then, creates an irrigation effect by drawing on the reservoir of accumulated moisture, raises the humidity, stills the wind in the community, and provides snow-drift moisture for its own subsequent use.

*Competition Effect.*—Sagebrush in the area appears to be a poor-land weed, moving into areas where the fertility is severely depleted. Sagebrush first appears in the swales where snow accumulation causes preferential grazing and a severe drain on fertility—nitrates, phosphates, potash.

A sagebrush-alfalfa test was set up to see if the alfalfa would fertilize the native grasses and cause a build-up of the soil organic matter. It was reasoned that the grasses would once again dominate to the exclusion of the sagebrush.

The study was made on a south facing slope, elevation 5,500 ft. Alfalfa seed was broadcast before a heavy disc was used to remove two-thirds of the sagebrush. It was considered desirable to allow as much sagebrush to remain as possible to provide a constant supply of seed. Grazing has been regulated to favor the alfalfa, i.e. the grazing has been intense for short periods in contrast to long grazing periods that would be detrimental to the alfalfa.

After 18 years of fertility and soil organic matter build up, the sagebrush in the areas of thick alfalfa is pretty well gone. As old sagebrush plants die there are no young ones coming on to take their place. In the same area, under the same grazing management without the alfalfa sagebrush is continuing to thrive and increase.

*Organic Matter Build Up.*—It appears that the main source of nitrogen and phosphate for range grass growth comes from the decomposition of the soil organic matter. With a legume that supplies the large amount of nitrogen and phosphate that alfalfa does, the trend of organic matter depletion could be reversed to one of accumulation.

*Role of Range Legumes.*—It would seem that legumes are the second step in rangeland intensification. Nitrogen, and in the case of deep-rooted legumes, phosphate and potash can be provided with much less cost than with fertilizer. Changes in grazing management, and an understanding of the growth requirements of the legumes are needed.

## LITERATURE CITED


ALLISON, FRANKLIN E. Nitrogen and Soil fertility. U.S.D.A. Yearbook of Agr. 1957. p. 85–100.

BOULTON, J. L. 1962. Alfalfa. Interscience Publishers, N.Y. 474 p.

DAVIS, WILLIAM. 1960. The Grass Crop. E. and F. N. Spon, London. 312 p.

DAVIS, WILLIAM. 1966. Proceeding, 10th International Grassland Congress. Herbage Abstracts, Commonwealth Agricultural Bureaux, Bucks, England 36:217–222.

DAUBENMIRE, R. F. 1947. Plants and environment. John Wiley and Sons. N.Y. 423 p.

ELLISON, W. 1958. Role of legumes in farm ecology. Nutrition of the legumes. Academic Press, N.Y. p. 308–321.

FREYMON, S., AND V. C. BRINK. 1967. Nature of ice injury to alfalfa. Agron. J. 59:557–560.

LEVY, E. BRUCE. 1955. Grasslands of New Zealand. R. E. Owen, Wellington, New Zealand. 321 p.

MILES, ARTHUR D. 1954. Improved pasture for spring and summer, range for fall and winter. J. Range Manage. 7:149–152.

MILES, ARTHUR D. 1958. Natural sources of nitrogen and phosphate for grass growth. J. Range Manage. 11:125–128.

MORRISON, FRANK B. 1956. Feeds and Feeding. 22 Edition. Morrison Publishing Co., Ithaca, N.Y. 1165 p.

PIETERS, ADRIAN J. 1927. Green manuring. John Wiley and Sons, N.Y. 356 p.