

GOOD PASTURES PAY

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Fig. 1.—These steers, photographed September 16, 1950, gained 2.24 pounds per head daily and 359 pounds an acre on brome grass and ladino. This 5-acre pasture, located between Lathrop and Plattsburg, carried 5 2-year-old steers from April 27 to October 3, 1950.

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GOOD PASTURES PAY

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Pastures produce feed at low cost. This has long been known and is generally accepted by Missouri farmers. It is one of the reasons why ten million acres, almost one-third of all Missouri farm land, is in pastures. Now we find that pastures seeded to high-yielding, nutritious, well-adapted grass-legume mixtures on soils adequately fertilized and limed also produce large yields of meat, milk, or wool. For example, two-year-old steers gained 254 pounds an acre annually on 35 acres of pasture in northwestern Missouri during the 5-year period 1946 through 1950. The average annual gain was 304 pounds an acre on the best 5-acre unit of these experimental pastures near Lathrop.

Average annual beef cattle gains of 294 pounds an acre were obtained on 3 experimental pastures in southeastern Missouri over a 3-year period, 1948 through 1950. The best pasture produced an average annual gain of 315 pounds an acre. Steers which grazed 25 acres of experimental pastures on the Southeast Missouri Experiment Station gained enough during 1949 to return \$36.00 for each acre of pasture used, although they were sold September 22 for 3½ cents a pound less than they had cost March 19. In 1950 beef steers grazing the same pastures returned \$39.50 an acre although one of the 20 steers died from bloat. Many farmers in Missouri have obtained even larger returns from good pastures. Because there is no expense for harvesting and little soil depletion, net returns from pastures compare favorably with those obtained from crops of grain, cotton, or hay.

PASTURE CROPS AND MIXTURES

All pastures, except some annual pastures, should contain one or more adapted grasses and one or more adapted legumes. In addition to supplying much of the edible herbage, grass protects legumes from injury by heaving, holds the soil against erosion while the land is in grass and for a year or two afterward, and reduces the danger of ruminants bloating on alfalfa or clover. Legumes not only furnish much palatable and nu-

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trititious herbage but they also supply the companion grass with additional nitrogen fixed from the air, and they thereby increase the total yield and improve the quality of pasture herbage.

Several good pasture grasses and legumes are well adapted to grow in Missouri. Choice of a particular grass-legume mixture will depend upon the depth, drainage, and fertility of the soil, and how long the field is to be left in grass.

It is best, if possible, to correct unfavorable soil conditions and to sow for pasture the most nutritious, palatable, and productive grass-legume mixture that is adapted to the climate. It is not, however, always possible to drain wet soils, to shatter clay-pans, or to protect the land from floods. It also may be physically impossible or economically impracticable to raise an impoverished soil to a high level of fertility by the first soil treatment. Fortunately, certain grasses and legumes will produce satisfactory yields of palatable and nutritious herbage even if grown on soils that are no better than medium in fertility; some will grow successfully on wet, heavy textured soils and on clay-pan or other shallow soils; and at least one pasture grass will survive deep flooding.

If, therefore, unfavorable soil conditions will be corrected only partially or not at all by soil treatment, tillage, or drainage, it will be necessary to choose for the pasture, seeding the best grasses and legumes which will tolerate the unfavorable conditions.

ROTATION PASTURES

Large and profitable animal production can be obtained from rotation pastures which consist of "hay-type" grasses and legumes grown on crop land. Rotation pastures, intended to last from 2 to 4 years only, fit into the regular crop rotation, following small grain and preceding the row crop. If the spring growth is not needed for pasture it can be harvested for hay or for grass silage and the subsequent summer growth can then be used for supplementary pasture.

Grasses and legumes used in rotation pastures must be productive, palatable, nutritious, and easy to establish but they need not be long-lived. Mixtures suitable for different situations in Missouri are:

For Deep, Fertile, Well-Drained Soils

1. Bromegrass 8-10 and alfalfa 8-10 pounds an acre
2. Bromegrass 8-10 and ladino 1 pounds an acre
3. Timothy 5-10 and alfalfa 8-10 pounds an acre

For Shallow Soils or Infertile Soils Fertilized and Limed Adequately

4. Timothy 5-10 and ladino 1 pounds an acre
5. Timothy 5-10, red clover 5, and ladino $\frac{1}{2}$ pounds an acre
6. Timothy 5-10, alsike 3, and ladino $\frac{1}{2}$ pounds an acre
7. Tall fescue 10 and sweetclover 10 pounds an acre

For Infertile Soils to Which Only a Moderate Amount of Fertilizer Will Be Applied

8. Timothy 5-10 and annual lespedeza 15 pounds an acre
9. Orchardgrass 10 and annual lespedeza 15 pounds an acre
10. Tall fescue 10 and annual lespedeza 15 pounds an acre

PERMANENT PASTURES

Much farm land should be left permanently in grass because of steep slopes or for other reasons. Pastures intended to occupy the land for 8 or more years are usually called permanent pastures. Such pastures may be tilled, fertilized, and reseeded (renovated) from time to time, but they are seldom plowed out and planted to row or close drilled crops. At least one of the grasses and one of the legumes used in a permanent pasture mixture should be either long lived or a consistent reseeder.

Mixtures suitable for permanent pasture in Missouri are:

For Deep, Fertile, Well-Drained Soils

1. Bromegrass 10 and ladino 1 pounds an acre
2. Bromegrass 5, timothy 3, and ladino 1 pounds an acre
3. Bromegrass 10, alfalfa 6, and ladino $\frac{1}{2}$ pounds an acre
4. Bromegrass 10, red clover 5, and ladino $\frac{1}{2}$ pounds an acre

For Shallow or Infertile but Well-Drained Soils Fertilized and Limed Adequately

5. Orchardgrass 10-15 and ladino 1 pounds an acre
6. Orchardgrass 10-15, red clover 5 and ladino $\frac{1}{2}$ pounds an acre

For Wet, Heavy Clay, or Clay-Pan Soils Not Subject to Flooding,

Fertilized and Limed Adequately

7. Tall fescue 10, alsike 3, and ladino $\frac{1}{2}$ pounds an acre

For Infertile Soils to Which Only a Moderate Amount of Fertilizer Will Be Applied

8. Orchardgrass 10 and annual lespedeza 15 pounds an acre
9. Tall fescue 10 and annual lespedeza 15 pounds an acre
10. Redtop 5 and annual lespedeza 15 pounds an acre

For Lands Subject to Flooding, but Only on Soils Adequately Supplied With Nitrogen and Mineral Plant Foods

11. Reed canarygrass 6-8, timothy 3, and alsike 3 pounds an acre

ANNUAL PASTURE CROPS

Annual pasture crops occupy the land for but a single year, although such an annual mixture as wheat-lespedeza may be grown repeatedly on the same field.

1. Rye 2 bushels an acre

2. Rye 1½ bushels and hairy vetch 15 or crimson clover 10 pounds an acre
3. Rye 1 bushel, ryegrass 10 pounds, and hairy vetch 15 or crimson clover 10 pounds an acre
4. Wheat 1½ bushels an acre
5. Winter barley 2 bushels an acre
6. Winter oats 2½ bushels an acre
7. Annual lespedeza (in grain crop) 25-30 pounds an acre
8. Sudangrass 25 pounds an acre

BROMEGRASS

On soils that are deep, well drained, and that contain at least a moderate amount of organic matter and a good supply of phosphorus, calcium and other mineral plant foods, brome grass is productive, palatable, nutritious, and long lived. Although creeping underground stems (rhizomes) will cause sparse stands to thicken, brome grass crowds companion legumes less than most adapted pasture grasses and it is easily eradicated by plowing.

Although an excellent pasture grass, brome grass has faults and limitations. Like alfalfa, its roots must have plenty of room in which to grow and if their downward extension is limited by a clay-pan, hard-pan, rock, or high water table, the above-ground growth and the lateral spread of the plant are so retarded that brome grass is neither high yielding nor



Fig. 2.—Steers gained 385 pounds an acre during 1949 on this brome grass-alfalfa pasture located in southeastern Missouri near Sikeston. These 660 pound steers had just been turned on this 5-acre pasture when photographed April 19.

able to withstand the encroachment of weeds and better adapted grasses.

Bromegrass has an even higher nitrogen requirement than most other grasses. Unless the soil contains at least a medium supply of organic matter as indicated by dark color or by soil test, nitrogen must be added to the soil at seeding to insure an adequate stand of bromegrass. Where this was not done on Dexter Fine Sand of the Sikeston Ridge, too little grass was established in a bromegrass-ladino mixture to protect cattle from bloating, although bromegrass was sown at 50 per cent above the recommended rate.

Bromegrass becomes "sod-bound" and makes small growth on even the more fertile soils unless nitrogen is supplied liberally by a companion legume or by annual or more frequent applications of fertilizer.

Bromegrass seeds are large, light, and chaffy and they do not flow readily through seeders and drills. Seeding machines must be equipped with special agitators to prevent bridging over the openings or the grass seed must be mixed with heavier material such as oats, phosphate fertilizer, or limestone.

There are two well defined types of bromegrass: southern, early maturing; and northern, late maturing. Only the southern type is adapted to the climate of Missouri. Varieties of this type now available are Lincoln (Nebraska), Achenbach (Kansas), Elsberry (Missouri), and Fischer (Iowa). Two improved varieties of the southern type, Lancaster and Lyon were released recently by the Nebraska Agricultural Experiment Station.

LADINO

Ladino is a strain of white clover which is much superior to common white clover and somewhat superior to Louisiana white clover in herbage yield and in drought survival, and equal to them in palatability and in nutritive quality. It also releases to companion grasses more fixed nitrogen than most other legumes.

Numerous fleshy, prostrate stems (stolons) grow horizontally so that a single ladino plant may extend over several square feet. Because of this and the small size of the seed (800,000 seed per pound) a pound of seed is usually enough to sow an acre. The herbage available to grazing animals consists entirely of leaves and blooms that grow from nodes (joints) of the stolons. Fibrous roots grow from the same joints.

Ladino thrives with bromegrass on the deeper soils and it also grows successfully with other grasses on shallower soils and on wet, heavy clays (gumbo) although it does not withstand flooding longer than a few hours.

Ladino will grow on light colored soils low in organic matter if such soils are well supplied with phosphorus, potash, and calcium (lime). It is particularly sensitive to a phosphorus deficiency. Soils low in phosphorus require from 600 to 900 pounds of 0-20-0 or from 1000 to 1500 pounds of



Fig. 3.—This bromegrass-ladino pasture, near Sikeston, was sown September 2, 1948, and was photographed April 19, 1949. Steers gained 301 pounds an acre on this pasture, but 6 of the 7 steers bloated repeatedly after June 7. This sandy soil was well supplied with mineral nutrients but it was deficient in organic matter and nitrogen.

rock phosphate an acre for the satisfactory growth of pasture mixtures of which ladino is the principal legume.

Ladino has two serious defects. It is more likely than other legumes to cause cattle and sheep to bloat and it stops growing and begins to wilt sooner than other legumes during dry weather.

At Lathrop, 4 steers grazed ladino and a sparse stand of bluegrass and redtop from April 25 to June 21, 1949 without visible symptoms of bloat, and then one died. At Sikeston, 7 steers grazed ladino and a sparse stand of bromegrass from April 19 to June 7, 1949 without visible symptoms of bloat, but after that date 6 of the 7 steers bloated repeatedly. Four steers grazed the same pasture from June 30 to September 15, 1950, with only slight bloating, and then one died. Farmers have had similar experiences.

On the other hand, 5 steers grazed at Lathrop a bromegrass-ladino mixture, of which bromegrass supplied at least 50 per cent of the forage during 1949 and 1950, without visible symptoms of bloat and gained 328 pounds an acre annually during this 2-year period.

In order to insure against the danger of ruminants bloating on ladino,

sow with the clover a grass adapted to existing soil conditions, sow enough grass seed, and stimulate early seedling growth by applying near the seed enough nitrogenous or mixed fertilizer to supply 30 or 40 pounds of nitrogen an acre if the soil is deficient in organic matter and in available nitrogen.

Only 0.36 inch of rain fell at Sikeston from July 15 to August 15, 1949, although rain was abundant before and after those dates. The bromegrass-alfalfa pasture and the lespedeza pasture each carried well one steer per acre during this dry period but all cattle had to be removed from the bromegrass-ladino pasture because of a shortage of forage. Although ladino survives moderate drought, its growth is retarded quickly by moisture deficiency so that a drought resistant pasture is needed to supplement ladino-grass mixtures during summer even more than to supplement permanent or rotation pastures which contain other legumes. The growth of ladino is not, however, retarded by hot weather if plenty of moisture is available.

Some drills and grass seeders cannot be adjusted to sow as little as 1 pounds of ladino seed an acre. If timothy is included in the grass mixture, ladino seed can be diluted with timothy seed. Alfalfa or redclover can be used for the same purpose with the additional advantage of adding to the mixture legumes which tolerate dry weather better than ladino both as seedlings and as established plants. Alsike seed also mixes well with that of ladino and should be sown with it on wet lands.

Ladino has no equal as a pasture for hogs and poultry. Because they do not bloat and because the sanitation they require to control internal parasites prevents the continued use of any pasture, grass need not be sown with ladino for this purpose. For such pastures ladino should be seeded at the rate of 2 pounds an acre with oats, which should be pastured off or should be mowed when fully headed.

ALFALFA

Alfalfa grown with grass makes excellent pasture for all classes of livestock. Although cattle and sheep can not graze pure stands of alfalfa safely, steers never bloated on a bromegrass-alfalfa mixture at Lathrop during 1 year of grazing, nor at Sikeston during 3 years, although alfalfa provided more than 50 per cent of the available forage at Sikeston during 1948. Steers gained 332 pounds an acre on bromegrass-alfalfa during 1945 at Lathrop, and 315 pounds an acre annually at Sikeston during the 3-year period 1948 through 1950.

The short life of pastured alfalfa limits its use to rotation pastures. Useful stands of alfalfa seldom persist longer than 3 years in pastures even if carefully managed and one year of close grazing will eliminate it. The useful life of bromegrass-alfalfa pastures has been extended successfully in 2 trials at Lathrop and in one at Sikeston by sowing ladino in the

bromegrass after much of the alfalfa had died. The bromegrass sod was disked at Sikeston, but not at Lathrop.

The fact that alfalfa grown with grass for pasture, like alfalfa grown alone for hay, thrives only on soils that are deep, well drained, and fertile limits still further its use for pasture.

ORCHARDGRASS

Orchardgrass produces as much forage as bromegrass or timothy and although it is somewhat less palatable than either, cattle and sheep will eat enough of it to supply their nutrient requirements for high production. In Missouri orchardgrass lives longer under grazing than timothy, but not as long as bromegrass, and being a bunch-grass, thin initial stands do not thicken. For this reason, orchardgrass should be sown at the rate of 10 pounds an acre if sown in late summer and at the rate of 15 pounds an acre if sown in the spring, or if sown in late summer under less than the most favorable conditions.

Orchardgrass will grow successfully on soils low in organic matter and on shallow soils if surface drainage is good. On level clay-pan soils that retain excess moisture near the surface during winter, heaving caused by alternate freezing and thawing weakens the plants and often destroys the stand within 3 years after seeding. Tall fescue and redbud are better grasses for such land.

Orchardgrass, because of its adaptation to soils low in organic matter and its better sustained growth during summer, is a good companion grass with ladino on soils not suitable for growing bromegrass. The mineral requirements of ladino must, of course, be met by adequate applications of lime and fertilizer.

Orchardgrass and annual lespedeza supply good grazing on limed but unfertilized soils of medium fertility and on poor soils if limed and fertilized only moderately. A badly eroded and exhaustively cropped field at Columbia that was limed, fertilized, and seeded to orchardgrass and Korean lespedeza in 1945, produced an average annual beef cattle gain of 184 pounds an acre during the 3 successive years 1946 through 1948. This pasture was still good during 1949 and 1950, but cattle were not available to measure its productivity during those years.

Useful stands of orchardgrass persist 8 to 10 years in well managed pastures.

TALL FESCUE

Tall fescue produces large yields of both forage and seed, it is long lived, it resists the encroachment of weeds, it will grow on almost any soil, it is easy to sow, and when established it holds the soil tenaciously against erosion, but it is comparatively unpalatable, especially during summer.



Fig. 4.—Tall fescue (Alta) growing on the farm of C. L. Van Buren near Lathrop, as it appeared June 13, 1946. This field, seeded in August 1944, and fertilized with 200 pounds ammonium nitrate an acre in October 1945, produced 350 pounds of re-cleaned seed an acre in 1946.

Experiments have shown that most beef steers will eat only enough tall fescue during July and early August to satisfy their maintenance requirements. Yet 5 two-year old steers grazing 5 acres of tall fescue at Columbia from May 6 to July 10, 1950 gained 2.18 pounds per steer daily, and when returned to this pasture August 21, gained 1.54 pounds per head daily until September 28. Lespedeza growing with the tall fescue in this pasture supplied almost none of the herbage before July 10, and less than one-half of it after August 21.

Five steers grazing $2\frac{1}{2}$ acres of tall fescue and ladino at Lathrop gained 2 pounds per head daily from August 2 to 30, 1949, and the same number of steers gained 0.93 pounds per head per day from July 6 to August 17, 1950. The average daily rate of gain on this pasture from April 27 to September 21, 1950 was 2.33 pounds, and the average annual gain per acre for the 2 years, 1949 and 1950, was 363 pounds.

Beef steers gained 293 pounds an acre during 1950 on tall fescue and ladino seeded August 26, 1949 on a badly eroded but adequately fertilized and limed field of the South Farm at Columbia. A mixture of tall fescue and second-year sweet clover produced beef cattle gains of 353 pounds an acre at Sikeston during 1948, and after these steers were removed Sep-

tember 10, the fescue made enough growth, which remained fully green until January, to maintain 3 cows per acre from December 10 to 31.

No steer has been observed to bloat in any of these experiments either on tall fescue and ladino or on tall fescue and sweet clover.

If the soil is suitable for growing either bromegrass or orchardgrass, one of these more palatable grasses is better than tall fescue for use in mixtures with ladino. Some farmers, however, who have lost cattle from bloat on ladino and sparse stands of bromegrass prefer to sow tall fescue with this clover even on land that is suitable for bromegrass. Tall fescue is the best grass to grow with ladino on wet, heavy clay, or gumbo soils, or on the level, clay-pan soils where orchardgrass is known to heave badly.

Tall fescue resists freezing and remains green later in the winter than other pasture grasses, if plenty of nitrogen is made available by the companion legume or by annual applications of nitrogen fertilizer made early in September. The leaves have been observed to remain completely green until the end of December in central and southern Missouri, and from one-half to two-thirds green all winter in the southern part of the State. Cattle show a preference for tall fescue after October even if bromegrass and orchardgrass are equally available.

Tall fescue does not continue to grow during cold weather but the fall growth, if saved, provides good late fall and winter pasture. Sods mowed and fertilized with 200 pounds of ammonium nitrate an acre early in September produced new growth equivalent to 1500 pounds of hay an acre by early November. Furthermore, tall fescue sod can be pastured at times when wet or recently thawed fields of rye or of winter barley would be too soft. Tall fescue fertilized with nitrogen in March will be ready to be grazed 2 weeks earlier in the spring than other pasture grasses.

Tall fescue sown at not less than 25 pounds of seed an acre is an excellent grass for terrace outlets, for grass waterways, and for other soil holding purposes.

The 2 varieties of tall fescue now available, Alta, selected by the Oregon Experiment Station and Kentucky 31, developed by the Kentucky Experiment Station, appear to be equally well adapted in all sections of Missouri.

ANNUAL LESPEDEZAS

Lespedeza, because of its wide soil adaptation, high palatability and nutritive quality, good summer growth, ease of initial establishment and consistent reestablishment by self-seeding, and an abundant supply of seed at reasonable prices, still occupies more acres of pasture in Missouri than any other grass or legume.

Of the two species, Korean (*Lespedeza stipulacea*) and Kobe

(*Lespedeza striata*), Korean is much more generally used in Missouri because the seed is more readily available at a lower price and because it will reseed before frost in all parts of the State. The later maturing Kobe is, however, better than Korean for use with orchardgrass, redtop, or tall fescue for pasture in the southern one-third of Missouri because it withstands better the competition offered by these grasses and because it is less susceptible than Korean to injury by bacterial wilt which is more injurious to lespedeza growing in grass sod than to lespedeza in grain stubble. It is expected that early-maturing strains of *L. striata*, now in the making, will gradually replace Korean in grass-legume mixtures for the establishment of new pastures and for the renovation of existing pastures, although Korean probably will continue to be sown with cereal crops for summer pasture.

Alfalfa, ladino, and birdsfoot trefoil produce on soils naturally suitable for their growth, or made suitable by soil treatment, larger yields of forage than lespedeza. Much Missouri land, however, especially that used for pasture, is not and can not be made suitable for growing alfalfa; most of it requires expensive soil treatment to make it suitable for growing ladino; and birdsfoot trefoil is difficult and costly to establish. Lespedeza, on the other hand, can be grown successfully on any cleared land in the State with a minimum of seedbed preparation and without too expensive soil treatment, although the productivity of lespedeza is increased substantially and profitably by liming the soil according to its need for calcium and by applying at least moderate amounts of needed fertilizer. During the 5-year period, 1946 through 1950, beef steers gained 210 pounds per acre annually on bluegrass and lespedeza growing at Lathrop on a soil shown by soil test to be slightly acid and low in phosphorus although not too low to support a 75 per cent stand of bluegrass. The 3 steers that grazed this 5-acre pasture from April 27 to October 3, 1950, gained 2.48 pounds per steer per day, or a total of 237 pounds an acre. Steers gained 1.94 pounds per day and 279 pounds an acre from May 6 to September 27, 1950 at Columbia on a mixture of bluegrass and Kobe lespedeza as compared with gains of 1.50 pounds per day and 216 pounds an acre on the adjoining bluegrass pasture that contained no lespedeza.

Although sowing lespedeza in bluegrass sod without soil treatment increased beef cattle gains by 55 per cent over a 5-year period (1940 through 1944) at Lathrop, lespedeza is not the best legume to use in pastures that are heavily fertilized for maximum production. A bluegrass-lespedeza pasture to which the equivalent of 1500 pounds of 0-20-0 was applied produced only 12 pounds larger beef cattle gains per acre annually during 1946 through 1950 than another bluegrass-lespedeza pasture that received no fertilizer. This does not prove that fertilizing pastures does not pay, but it does demonstrate that the more productive legumes, al-

falfa and ladino, should be grown instead of lespedeza in the more heavily fertilized pastures.

Numerous experiments have shown that lespedeza grown with wheat, oats, rye, or barley will supply from July to October pasture on which cattle will gain up to 100 pounds an acre, if the cereal is harvested for grain, and up to 150 pounds an acre, if the grain crop is pastured off or if it is cut early for hay.

TIMOTHY

Timothy, long and extensively grown for hay, also is a good pasture grass, but it is short lived under grazing. It is, therefore, most useful in rotation pastures not intended to last longer than 3 years, and particularly on soils not suitable for bromegrass and alfalfa. Because, however, the seed is cheaper and easier to sow and because fewer pounds of seed are required to establish comparable stands of grass, timothy can be substituted for one-half of the bromegrass seed in establishing a pasture to last more than 3 years and for all of the bromegrass in a mixture designed to be pastured 3 years or less. As the timothy plants die bromegrass will spread and replace them.

Sow 3 to 5 pounds of timothy seed an acre if timothy is sown in late summer without a companion crop, or if it is sown with wheat after the fly-free date; sow 10 pounds if it is seeded in the spring with oats. The spring seeding will establish a thinner stand even at the higher seeding rate.

Timothy mixed with ladino may not grow enough during the summer to protect ruminants from bloating on the lush growth which the clover will make during a wet summer.

KENTUCKY BLUEGRASS

Kentucky bluegrass is the dominant species in most of the better permanent pastures of the State, especially those in Central and Northern Missouri. In most of these pastures, bluegrass has volunteered, replacing either timothy which had been grown for hay or the bluestems and other native grasses which failed to survive close grazing. Few pastures have been sown to bluegrass, and seeding it is not now recommended because bromegrass, orchardgrass, and timothy produce larger yields of herbage and offer less competition to companion legumes. Furthermore, if the soil is suitable for bluegrass, it will gradually invade the pasture so that any long-time advantage which might result from having bluegrass in the pasture will be obtained without sowing it.

Many low-yielding bluegrass pastures can be improved substantially and profitably by applications of lime and fertilizer and by establishing in them ladino, lespedeza, or birdsfoot trefoil. In comparatively few bluegrass pastures would it be good practice to destroy completely

the bluegrass in order to substitute other grasses, although this might be desirable in some instances.

RED AND ALSIKE CLOVER

Red clover and alsike are too short-lived to serve as the principal legumes in permanent pastures, although for lands exposed to floods alsike is the only available choice and alsike will reseed to a degree on wet lands. These clovers are valuable for use with timothy in rotation pastures; red clover for well drained land and alsike for wet soils. They also can sometimes be used to advantage with ladino in permanent pasture mixtures. If the weather is dryer than normal, a mixture of 5 pounds of red clover and $\frac{1}{2}$ pound of ladino seed will furnish more clover during the first and second years than ladino alone, and it is often better to sow $\frac{1}{2}$ pound of ladino with 2 to 3 pounds of alsike than to sow 1 pound of ladino as the only legume in the grass-legume mixture on poorly drained land or on gumbo soils.

REDTOP

Redtop is less productive and less palatable than orchardgrass. It is, however, better adapted to grow on level, clay-pan soils and on infertile soils than any other grass with the possible exception of tall fescue. Lespedeza grows better with redtop than it does with the more competitive tall fescue. The best pasture mixture for many badly depleted soils to which only light applications of fertilizer can be made before seeding is redtop and lespedeza.

At Columbia, beef steers gained during the 3-year period 1946 through 1948, 223 pounds an acre annually on redtop and lespedeza growing on a naturally infertile and exhaustively cropped clay-pan soil, which had, however, been limed and fertilized.

The useful life of an orchardgrass-lespedeza pasture also can be prolonged by adding to the seed mixture a pound or two of redtop seed for each acre sown.

BIRDSFOOT TREFOIL

Birdsfoot trefoil is better in some respects than any other legume for use in permanent pastures. It withstands crowding by such highly competitive grasses as bluegrass and tall fescue, and at the same time it releases to the grasses fixed nitrogen which increases their vigor. Pastures of bluegrass and birdsfoot trefoil have produced large beef-cattle gains in Indiana and in Iowa, and it is highly regarded as pasture for dairy cows in New York. Cattle have not been known to bloat on this legume, and it will grow on soils no better than medium in fertility.

Birdsfoot trefoil has, however, inherent weaknesses which at present seriously limit its usefulness in pastures. The seedlings are weak and slow growing, so that it must be sown in the spring, it furnishes little or

no grazing during the year of seeding, and it requires careful management to prevent its being smothered by the companion crop, by the grass associate, or by weeds during the first year. Thorough tillage, equivalent to plowing, is required for its establishment in grass sod, and seedlings are unable to compete with volunteer or sown lespedeza. Low seed yields and a tendency to shatter as soon as mature make the seed expensive, and disease may deplete or destroy the stand in the fourth or fifth year.

Better inoculation, improved seeding practices, and superior strains and varieties, now in process of development, may make birdsfoot trefoil easier and less expensive to grow, but until these improvements materialize, ladino or lespedeza had better be used in most pasture seedings.

Because, however, established plants of birdsfoot trefoil grow better than any other legume in bluegrass sod, some seed of birdsfoot trefoil should be included in any seed mixture that contains Kentucky bluegrass as the principal grass.

REED CANARYGRASS

Backwater from the Missouri River which flooded plots located between Waverly and Carrollton March 17 to 19, March 25 to 27, April 16 to 21, May 15 to 20, May 23 to 31, June 6 to 9, June 15 to 27, and July 1 to 9, 1945, killed redbud and tall fescue but did not kill reed canarygrass, which put out new leaves as soon as the water drained away.

In addition to its flood tolerance, reed canarygrass is high yielding, and it produces a large part of its leafy, palatable growth during summer



Fig. 5.—Reed canarygrass and alsike growing on wet land near Malta Bend, July 5, 1946.

when additional pasture often is most needed, and when grazing animals are least likely to bog down on low, poorly drained land.

Reed canarygrass is long-lived and sod-forming, which insures a gradual thickening of an initially thin stand, but only if the soil is well supplied with nitrogen. Reed canarygrass does best on dark colored soils that have a high organic matter content. Light colored soils must be fertilized heavily with nitrogen or must be manured heavily for the successful production of this grass.

It is advisable to sow timothy with reed canarygrass because of the high price of reed canarygrass seed. Alsike is the only legume adapted to the conditions for which reed canarygrass is best suited.

Because the seedlings will not survive flooding, which is more likely to occur in the late spring, late summer is the best time to sow reed canarygrass. It also can be sown broadcast during the winter on frozen ground if the seedbed has been prepared during the preceding fall.

SUDANGRASS

Sudangrass planted in late May or early in June will furnish good pasture from July to October. If lespedeza is not to be available in small grain stubble, sudan is the best crop to sow for summer supplementary pasture. Even if lespedeza is available, many dairy farmers prefer to have their producing dairy cows on sudangrass during September and October. For this purpose, sudangrass can be sown in late June on land from which wheat has been harvested or from which second-year sweetclover has been pastured.

There is little or no danger of cattle being poisoned by sudangrass if reasonable precautions are taken. Seed containing even a trace of sorghum seed should never be sown, and cattle and sheep should not be turned on sudangrass before it has grown to a height of 10 or 12 inches. Sudangrass that has been overgrazed or that has had its growth checked by drought or frost should not be grazed until the new shoots have grown 10 or 12 inches.

Young plants and new shoots of sudangrass contain more cyanogenic glucoside, the material which is converted into poisonous HCN in the rumen of cattle and sheep, than older plants or shoots, but even the young growth hardly ever contains lethal amounts, except where sudan is grown on soils high in organic matter and low in phosphorus.

When there is any doubt about the safety of sudan for pasture, turn in a single, less valuable animal a few hours before turning in the herd, and see that all cattle are well filled before they begin to graze sudan.

CEREALS FOR PASTURE

Cattle have made an average annual gain of 280 pounds an acre on wheat and lespedeza at Lathrop over the 5-year period 1946 through 1950.

Approximately one-half of this gain was made during April, May, and June while the lespedeza was still too small to supply an appreciable portion of the feed. Steers have gained 288 pounds an acre annually on wheat and lespedeza at Sikeston during the 3-year period, 1948 through 1950.

Although wheat has supplied more and better pasturage than other cereals from early April to mid June, it cannot be planted early enough to supply much fall grazing because of its susceptibility to injury by hessian fly. If the grain crop is to be sown in late August or early in September to provide fall pasture, rye can be used in any part of Missouri, winter barley in the southern one-half and winter oats in the southern one-fourth of the State. The 3 latter crops can, of course, be pastured in the spring as well as in the fall, and all 4 cereals will furnish some pasture throughout the winter in the southeastern lowlands.

Rye begins growth at lower temperatures than other cereals or grasses and it can be grazed from 2 to 3 weeks earlier in the spring, but it also becomes stemmy and unpalatable at an earlier date. Rye pasture will remain palatable and nutritious later in the spring if ryegrass, vetch, or crimson clover is sown with rye.

Spring oats is not a good crop for pasture, although it is often good practice to pasture off oats grown primarily as a companion crop.

Additional information on growing and using cereal crops for pasture is given in Missouri Agricultural Experiment Station Circular 335, An All-Year Pasture System for Missouri.

WINTER VETCH AND CRIMSON CLOVER

Winter vetch is a useful legume for late spring and early summer pasture in the southern part of the State. For a pasture it should be sown with barley or rye, at the rate of 15 to 20 pounds per acre in late August or early September. Inoculation is important for this crop.

A good stand of vetch will extend the pasture season in early summer, beyond the pasturing period of wheat, rye, or barley alone. If the vetch is not grazed too close and the animals are removed in mid-June, the crop will usually continue growth and produce enough seed to renew its stand on the same land in the fall. By disking to cover the seed, and reseeding the fall grain on the vetch sod, the vetch can be made to renew its stand annually, improve its growth, and add considerable fall pasturage to the grain pasture with which it is combined.

Crimson clover, a winter annual, also is a valuable pasture legume for late fall, winter, and spring. In Missouri the practical use of crimson clover is limited generally to the southern half of the state and the plant is there adapted only to warm and well drained soils of average to good fertility. The crop should be sown in late August or early September at

the acre rate of 10 to 15 pounds of seed in combination with 5 to 6 pecks of barley or rye. Crimson clover should not be sown alone for a pasture, except where it is known to grow vigorously on soil well suited to its needs. Nor is it to be recommended for any purpose on soils low in fertility, poorly drained, or acid. The new "reseeding" varieties of crimson clover, Dixie and others, should be used.

HOP CLOVER

Hop clover (*Trifolium procumbens*) is a yellow blossom, winter annual which has been introduced by natural seed dispersion into many Ozark pastures. Under favorable conditions, it will produce medium yields of high quality forage which can be pastured during April, May, and June or can be cut for hay in June. It will grow on infertile soils, and it reseeds consistently and abundantly, so that thin initial stands will thicken.

Better stands result from broadcasting the seed on closely grazed or mowed sods than from sowing it on a well prepared seedbed. Seeding should be done in late September as the seed germinates in October. Dry weather during October is the unfavorable condition most likely to cause partial failure of a new seeding or of a natural reseeding.

Hop clover is most useful in the southern one-half of Missouri for sowing on fields that cannot be tilled, fertilized, and limed for the establishment of more productive grasses and legumes. A pound or less of seed an acre is enough to sow.

WHEN AND HOW TO SOW

The best time to sow perennial grasses for permanent pasture is late summer: August 15 to August 31 in northern Missouri; August 20 to September 7, in central Missouri; and September 1 to 20 in southern Missouri. If either alfalfa or ladino is included in the pasture mixture, it also should be sown with the grass in late summer. Seedings of red clover and of alsike at this time are less likely to survive the winter, and annual lespedeza, birdsfoot trefoil, and sweet clover should be sown only in late winter or early spring.

Fall drought and grasshoppers may cause late summer seedings to fail, but spring seedings face the usually greater hazards of weeds and summer drought. Furthermore, pastures established in late summer can be utilized fully during the first year, while only limited use can be made of spring sown pastures during the year of seeding.

Rotation pastures usually are seeded in the spring, either on fall-sown grain or with oats, and permanent pastures can be sown at that time. If seeded in fall-sown grain, the grass-legume mixture either should be broadcast during late February or March while the ground is still freezing at night, or it should be drilled as early after spring thaws as the

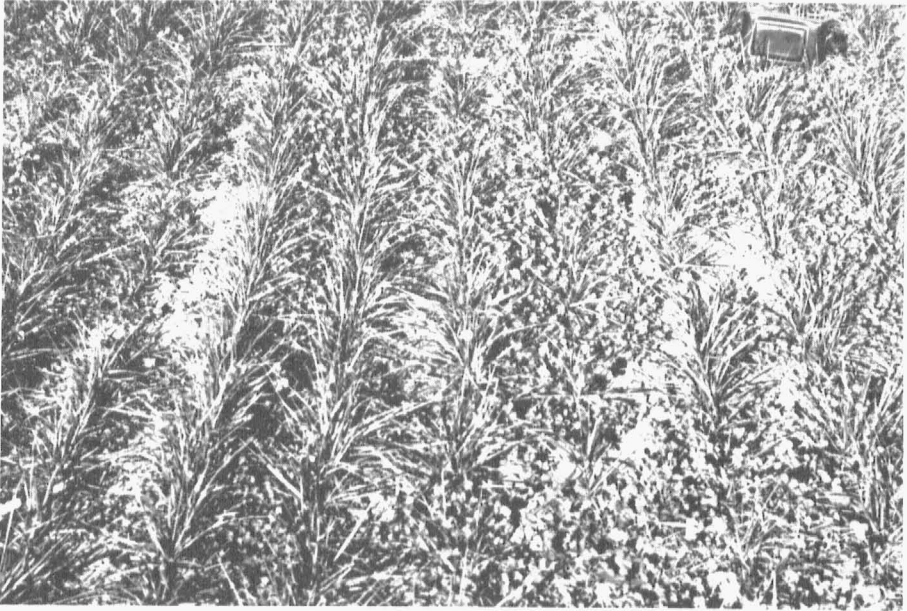


Fig. 6.—Tall fescue (Alta) and ladino, drilled August 29, 1949 on the farm of C. L. Van Buren near Lathrop and photographed November 10, 1949. This grass-legume mixture was ready to be grazed by April 25, 1950.

soil is firm enough to be driven over. Drilling is required if additional fertilizer is to be applied with the grass at seeding.

If the oat crop is planted primarily for grain production, it should be planted as early in March as the land can be worked, and the grass-legume mixture should be sown at the same time. If, however, the establishment of the grass-legume mixture is of primary importance, it usually is better to take more time for thorough seedbed preparation and delay the seeding until late March or early April.

Timothy, redbud, and bluegrass can be sown successfully with wheat or with other fall-sown grains after the fly-free date. If this is done, the legume should not be seeded until late winter or spring. It is not advisable to sow orchardgrass, bromegrass, or tall fescue as late as October except near the southern border of Missouri.

SEEDBED

In order to make the mellow, compact, weed and grass-free seedbed required for the satisfactory establishment of pasture grasses under any but the most favorable weather conditions, it usually is necessary to plow. A good seedbed is essential to the success of a late summer seeding because of the necessity for prompt germination and the danger of the soil drying after seed start to germinate. Plowing should be done several

weeks before seeding to allow time for rains and for disking, harrowing, and rolling to compact the soil and to germinate weed seed and to kill weed seedlings.

If old pastures to be renovated are so steep that the plowed surface might erode badly, only surface tillage with a bush and bog (cutaway) disk, disk harrow, or field cultivator may be feasible. The objective then is to kill existing plants and to leave the dead vegetation on the surface as a mulch. Successive cultivations, each at a right angle to the preceding one, made during dry, hot periods of summer may be required to subdue old sods of bluegrass, redtop, or other sod-forming grasses. Less tillage usually is required to kill competing plants where only weeds and weed grasses occupy the land. If, however, three-fourths or more of the surface is occupied by a sod-forming grass, even steep slopes can be plowed shallow with small loss from erosion.

No special seedbed preparation is required for spring seedings made in fall-sown grain. If, however, a grass-legume mixture is to be sown with oats, additional disking and harrowing to level the surface, to reduce clods, and to compact the soil to a degree not required to get a stand of oats, may mean the difference between success and failure of the pasture seeding.

COMPANION CROP

Pasture and meadow seedings often are made with a companion crop of wheat, oats, barley, or rye in order: (a) to produce grain while the grass-legume mixture is being established; (b) to reduce erosion until the grass-legume mixture provides a protective cover; and (c) to give the grass-legume seeding some protection from weeds. The grain crop does, however, retard the growth of intersown grasses and legumes by shading and by competing for limited supplies of soil nutrients and moisture. Seedling grasses and legumes dwarfed by the competing grain crop often fail to survive the hot dry weather that usually follows grain harvest. Grain crops also may lodge during unusually wet seasons, and lodging of the companion crop usually destroys the pasture seeding.

Competition by the grain crop with the grass-legume seedlings can be reduced by sowing early maturing, stiff strawed varieties of cereals, and by pasturing during March and early April before the grain "joints." Heavy applications of fertilizer, applied at the seeding of fall-sown cereals, and of nitrogen applied in the spring increase the harmful effects of the companion crop. Withholding one-half of the phosphate fertilizer until spring and drilling it then with grass and legume seed, on the other hand, increases growth of the seedlings and helps them to survive.

Reducing the rate of seeding spring-sown companion crops reduces the competition they offer the grass seeding, but the rate of sowing fall-sown grains has little or no influence on the competition they offer.

Companion crops should never be sown with pasture seedings made in late summer. Oats sown at one-half of the customary rate and pastured off or cut early for hay are, however, usually less harmful than the weeds with which a spring seeding must compete if no companion crop is used.

Rotation pastures are sown with whatever grain crop they are to follow in the crop sequence. If the grass-legume seeding made in grain should fail, it can be made again in late summer without any companion crop.

SEEDING METHODS

Poor stands develop from seed not covered or from seed covered too deep. Experiments have shown that the small seed of pasture grasses and legumes produce the largest percentage of emerged seedlings and that the seedlings are most vigorous if the seed is covered only one-fourth to one-half inch deep, and that very few seedlings emerge from seed placed deeper than one inch. Sudangrass seedlings because of the larger size of the seed can push up through 2 inches of soil. One essential seeding practice is, therefore, shallow placement of the seed; the other is uniform distribution. Since it is impossible to avoid placing some seed too deep in loose or cloddy soil, a compact seedbed is essential to shallow planting.

The seed can be broadcast by hand or by means of a cyclone or wheelbarrow seeder on the surface of a compact seedbed and can be covered by harrowing with the harrow teeth set nearly horizontal. No harrowing is required for an early spring seeding which will be covered by the first rain.

Good results have been obtained by rolling the land with a corrugated roller, or cultipacker, broadcasting the seed, and then rolling a second time at a right angle to the first. The first rolling compacts the soil and leaves shallow furrows into which much of the seed will fall; the second covers the seed shallow, presses the soil firmly about the seed so that they absorb moisture readily, and leaves a corrugated surface that is less likely to crust than a smooth one.

There is at least one seeder on the market that mounts a grass seeder which drops the seed between a large corrugated roller in front and a smaller one behind, by which rolling and seeding is done in one operation.

Grasses and legumes also can be sown either with a clover-alfalfa drill or by means of a grain drill equipped with a grass seeding attachment. If the latter is used on a seedbed that is less firm than it should be or if fertilizer or grain is drilled at the same time grass seed is sown, the grass-seeder spouts should be tied back to drop seed behind the drill disks.

Band seeding, recently devised by the Ohio Agricultural Experiment Station, not only gives better stands of pasture grasses and legumes but does it with one-third less seed. The short metal tubes of the grass-seeding attachment are replaced by lengths of garden hose the lower ends

of which are fastened just behind and a little above the grain-fertilizer tube outlets, so that the grass-legume seed will drop into the drill furrow directly above the band of drilled fertilizer, with about 1½ inches of soil separating seed and fertilizer. Experiments have shown that seedlings from seed placed directly over the bands of starter fertilizer grow more rapidly and have a better chance to survive adverse weather and weed competition than seedlings on either side of this band.

Seed of similar size and weight, such as timothy and clover, can be mixed and be drilled in one operation, but if the small, heavy seed of clover, alfalfa, or timothy is mixed with the lighter seed of orchardgrass, bromegrass, or tall fescue, the jolting of the seeder will cause the heavier seed to sift to the bottom and be planted first.

Bromegrass seed, which is light and chaffy, tends to bridge over seeder openings and to clog drill tubes. Some seeding machines are equipped with special agitators for sowing unmixed bromegrass seed, but it usually is necessary to mix bromegrass seed with heavier materials in order to get it through a drill. Ten pounds of bromegrass mixed with 5 or 6 pecks of oats can be drilled through the grain box and 10 pounds of bromegrass seed mixed with 150 pounds of phosphate fertilizer or with 150 pounds of ground limestone can be drilled through the fertilizer attachment. Shallow seeding is as essential with this method as with any other.

Bromegrass has also been sown successfully by dribbling the seed out of a scoop into an endgate seeder at the desired seeding rate.

FERTILIZER AND LIME

The poorest soils in Missouri will produce some grazing if seeded to annual lespedeza, hop clover, redtop, tall fescue or some combination of them. The application of lime and fertilizer is wholly impracticable on some rocky, stump strewn, precipitous slopes on which seed can be scattered only by hand. No pasture plant will, however, make much growth on impoverished soils without at least moderate applications of the required mineral plant nutrients and the more productive and palatable pasture grasses and legumes such as bromegrass, ladino, and alfalfa will not grow at all on infertile soils unless soil deficiencies are corrected by heavy applications of fertilizer and lime.

If the pasture mixture to be sown includes bromegrass, alfalfa, ladino, red clover, or reed canarygrass, the basic soil treatment should consist of the amount of phosphate, potash, and limestone which soil test shows that the soil requires. Thus, a soil low to very low in phosphorus will require from 600 to 900 pounds of 0-20-0, or from 250 to 400 pounds of 0-45-0, or from 1000 to 1500 pounds of rock phosphate an acre. A soil low to very low in potash will require from 200 to 300 pounds of 50 per cent muriate of potash an acre. A soil low in calcium will require from 2 to 4 tons of agricultural limestone.

Heavy applications of phosphate and of potash should be placed as deep as practicable, either by plowing the fertilizer down or by drilling it as deeply as possible in the plowed or disked ground. Limestone should be applied 6 to 12 months before sowing the legume of the pasture mixture, and it should be mixed with the surface 6 inches of soil.

In addition to this basic soil treatment, a starter fertilizer should be drilled shallow, and directly beneath the grass and legume seed (band seeding) if possible. For dark colored soils that contain at least a moderate supply of organic matter, 150 to 200 pounds of 0-20-0 or of 4-12-4, or 100 pounds of 0-45-0 an acre will serve this purpose. If the soil is light in color and low in organic matter, apply 200 to 300 pounds of 10-10-10, 8-8-8, 3-12-12 or similar fertilizer. Although placement of seed near and directly above bands of mixed fertilizer is desirable, seed should not be placed in contact with fertilizers that contain nitrogen or potash.

The starter fertilizer supplements, but does not replace the heavier basic application of phosphate, potash, and lime which soil test has shown the soil to require.

If the farm operator is unable or unwilling to make the heavy applications of fertilizer that may be required for maximum pasture production, smaller but profitable pasture returns can be obtained by sowing orchardgrass, redtop, tall fescue or timothy with annual lespedeza on infertile soils to which from 200 to 500 pounds of 4-12-4 or similar fertilizer is applied at or shortly before seeding. Enough limestone to satisfy the lime requirement of the soil should, however, always be applied before seeding, if a lime spreader can be driven over the land.

If less fertilizer than the soil needs is applied, additional applications will be required in a few years to maintain productivity of the pasture.

Alfalfa and ladino sown on soils that contain adequate supplies of mineral nutrients but that are deficient in organic matter, sometimes outgrow the companion brome grass. It is advisable, therefore, either to apply 30 or 40 pounds of nitrogen an acre in mixed fertilizers or as ammonium nitrate to such soils at seeding to stimulate growth of the grass, or to sow either orchardgrass or tall fescue instead of brome grass.

FIRST-YEAR MOWING AND GRAZING

If weeds threaten to smother seedling grasses and legumes, cut them with a mower. The taller the weeds are allowed to grow before mowing and the shorter they are cut, the better the control. Delay mowing, therefore, until the weeds begin to shade grass-legume seedlings excessively and then mow with cutter bar set close to the ground.

Pasture seedings made in the spring should not be grazed until growth attains a height of 5 or 6 inches, and continued close grazing should be avoided. They should also be protected from grazing during the first fall, September 15 to November 15. For management after the first year, see Missouri Agricultural Experiment Station Circular 335.