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# Report of Crop and Pasture Experiments at Lathrop in Northwestern Missouri; 1940-1944

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*Cooperatively Written by the Field Crops Department, Missouri Agricultural Experiment Station; The Division of Forage Crops and Diseases, Bureau of Plant Industry, Soils and Agricultural Engineering, Agricultural Research Administration, United States Department of Agriculture; and C. L. Van Buren, Lathrop, Missouri.*

COLUMBIA, MISSOURI

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Korean lespedeza after oats; July 15, 1942.

The Lathrop experiments were designed: (1) to measure on the upland soils of northwestern Missouri the productivity of wheat, oats, and winter barley combined with Korean lespedeza in 1-year rotations without plowing; and (2) to determine the extent to which established bluegrass pastures could be improved by sowing legumes in them, with or without the application of phosphate fertilizer and lime, on land that is naturally well adapted to grow Kentucky bluegrass.

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The experimental field in which these investigations were made was located south of Lathrop, in Clinton County, Missouri, on soil classified as Sharpsburg silt loam, a soil type that ranks between Grundy and Marshall in character and productivity. The land is gently rolling in topography with some slopes steep enough to erode severely when cropped with corn and other row-crops.

An approximate index of the productive capacity of this land is afforded by crop yields obtained on nearby untreated plots in soil fertility investigations, although these yields were probably enhanced by efficiencies of culture and harvesting that are practicable only on small plots. Average annual yields of major crops during the six-year period 1939 to 1944 were: corn 48 bushels per acre; oats 44 bushels; wheat 18 bushels; and alfalfa 2.8 tons of hay.*

## PART I.—ONE-YEAR ROTATIONS OF GRAIN AND KOREAN LESPEDEZA FOR NORTH-WESTERN MISSOURI

### Management of the Double Cropping Systems

The seedbed for winter barley was prepared each successive year by double-disking the ground in August as soon as practicable after the lespedeza had been harvested for hay. Winter barley was then drilled in early September at the rate of 2½ bushels of seed per acre.

The disk harrow also was used to prepare seedbeds for wheat and oats, as early in October as maturity of the lespedeza seed would permit in the case of wheat, and as early in the spring as the ground could be worked, in the case of oats.

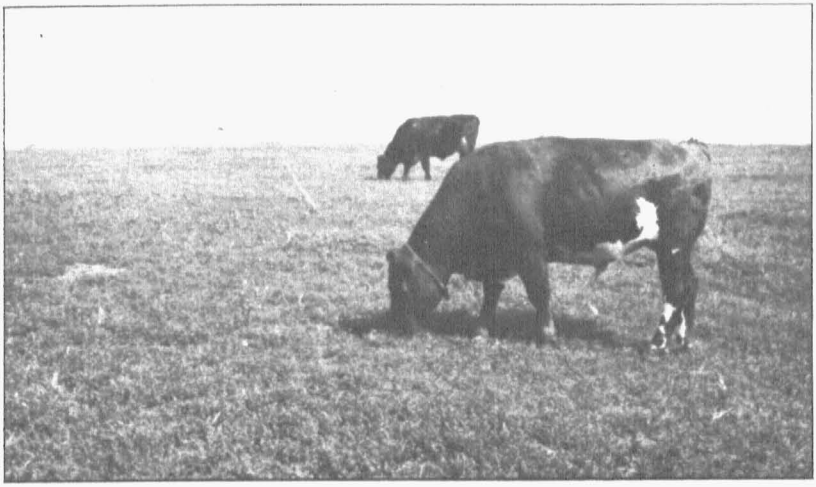
Wheat was drilled at the rate of 6 pecks of seed per acre and oats at the rate of 2 bushels.

Phosphate fertilizer (0-20-0) was applied at the rate of 150 pounds per acre annually with each of these grain crops at the time of seeding.

Korean lespedeza was reestablished in barley during each of the 5 years by broadcasting the seed at the rate of 40 pounds per acre in December. In oats, and in both fields of wheat, the lespedeza matured enough seed each fall, following its initial

*Unpublished data supplied by the Department of Soils, Missouri Agricultural Experiment Station.

seeding at the rate of 25 pounds per acre in 1939, to establish good stands without the planting of additional lespedeza seed.



Cattle pasturing Korean lespedeza after wheat had been harvested for grain, September 19, 1941.

Winter barley and oats were harvested for grain. The lespedeza that was grown with winter barley was harvested for hay in late July or early August. The lespedeza in the oat stubble was pastured off during the summer and early fall.

Two fields of wheat and Korean lespedeza were grown each year. The wheat in one of these fields was harvested for grain, after which the lespedeza was pastured. Both the wheat and lespedeza were used for pasture in the second field, grazing starting in April or early May and continuing until October.

### Production Obtained from 1-Year Rotations at Lathrop

Results obtained over a 5-year period from 1-year rotations of grain and Korean lespedeza grown in northwestern Missouri are summarized in Table 1.

The value of Korean lespedeza grown with winter barley in a double cropping system for the production of hay on moderately fertile land in northwestern Missouri was strikingly demonstrated by the average yield of 2 tons of hay per acre that was obtained over a 5-year period. Winter barley did not, however, prove to be either sufficiently productive or winterhardy to

justify its general use in that section of the State for grain production. Although lespedeza could be expected to produce a somewhat smaller yield of hay if grown with more hardy and later maturing cereals, both wheat and oats are more dependable and more productive grain crops than any varieties of winter barley yet available for use in the northern part of Missouri in 1-year rotations with Korean lespedeza. Wheat and oats have the additional advantage of not having to be planted until after the lespedeza has matured enough seed to establish another crop.

TABLE 1. - YIELDS OF GRAIN AND HAY, AND BEEF-CATTLE GAINS OBTAINED FROM 1-YEAR ROTATIONS OF GRAIN AND KOREAN LESPEDEZA AT LATHROP.

| 1-year rotation | Item | Production per acre | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1940 | 1941 | 1942 | 1943 | 1944 | Average |
| Winter barley-Korean lespedeza | bu. grain | 28 | * | 19 | 5 | 24 | 15 |
| | tons hay | 1.0 | 2.5 | 2.0 | 2.0 | 2.4 | 2.0 |
| Oats-Korean lespedeza | bu. grain | 39 | 35 | 35 | | | 36 |
| | lbs. gain | 87 | 58 | 59 | | | 68 |
| | pasture days | 71 | 89 | 53 | | | 71 |
| Wheat-Korean lespedeza | bu. grain | 25 | * | 17 | 12 | 20 | 15 |
| | lbs. gain | 98 | 206 | 92 | 65 | 100 | 112 |
| | pasture days | 57 | 142 | 78 | 90 | 53 | 84 |
| Wheat-Korean** lespedeza | lbs. gain | 301 | 207 | 345 | 316 | 205 | 275 |
| | pasture days | 134 | 142 | 162 | 154 | 165 | 151 |

* Barley and wheat winter killed.
** Wheat and lespedeza used entirely for pasture.

The 1-year rotation of oats for grain and lespedeza for pasture was discontinued after 1942, but during the 3 years that this combination of crops was continued, the total average annual production of 36 bushels of oats and 68 pounds gain in weight by beef cattle was a satisfactory return from the land. Furthermore the almost continuous plant cover of oats and lespedeza reduced to a low level soil losses by erosion from this moderately sloping field in which evidence of erosion prior to 1939 was clearly apparent.

Although 15 bushels of wheat per acre is not in itself a high average yield, this amount of grain plus an average annual gain in weight of 112 pounds per acre made by beef cattle pasturing the associate crop of lespedeza after wheat harvest is indeed high production. The average grain yield for the 5-year period

was reduced substantially by one complete failure that resulted from the unprecedented Armistice day freeze of 1940.* The loss of the 1941 wheat crop was, however, to a large extent compensated for by the increased pasturage supplied by lespedeza. Although the average farmer might not be able to utilize for pasture an unanticipated large increase in the production of lespedeza that might result from a failure of the wheat, the surplus lespedeza could be harvested for hay or seed, or both.

TABLE 2. - GRAZING SCHEDULE FOR EXPERIMENTAL BLUEGRASS PASTURES AT LATHROP.

| Year | Pasture | Periods when each pasture was grazed * |
|---|---|---|
| 1940 | A | April 25 to June 24 |
| | B | April 25 to June 24 |
| | C | April 25 to July 4 |
| | D | April 25 to May 5; July 19 to Sept. 6 |
| 1941 | A | April 21 to July 31 |
| | B | April 21 to July 31 |
| | C | April 21 to July 31 |
| | D | April 21 to July 31 |
| 1942 | A | April 21 to July 31 |
| | B | April 21 to July 31 |
| | C | April 21 to July 31 |
| | D | April 21 to July 31 |
| 1943 | A | April 15 to July 2 |
| | B | April 15 to July 2 |
| | C | April 15 to May 6; July 16 to Sept. 1 |
| | D | April 15 to July 16; Sept. 1 to Oct. 15 |
| 1944 | A | May 5 to July 7, Oct. 6 to Oct. 31 |
| | B | May 5 to Sept. 2; Oct. 6 to Oct. 31 |
| | C | May 12 to July 7; Sept. 3 to Oct. 31 |
| | D | May 5 to May 12; July 7 to Sept. 3 |

* Winter grazing not included

When used entirely for pasture, the 1-year rotation of wheat and Korean lespedeza produced gains in weight by beef cattle that ranged from 207 pounds per acre in 1941, when the wheat failed completely, and 205 pounds per acre in 1944, when lespedeza failed partially, up to 345 pounds per acre during 1942. The average annual gain for the 5-year period was 275 pounds per acre. By comparison, the average annual gain made during the same period on an improved bluegrass pasture was 185 pounds per acre (Table 2).

*Most of the wheat planted on or after the fly-free-date in this vicinity was killed.

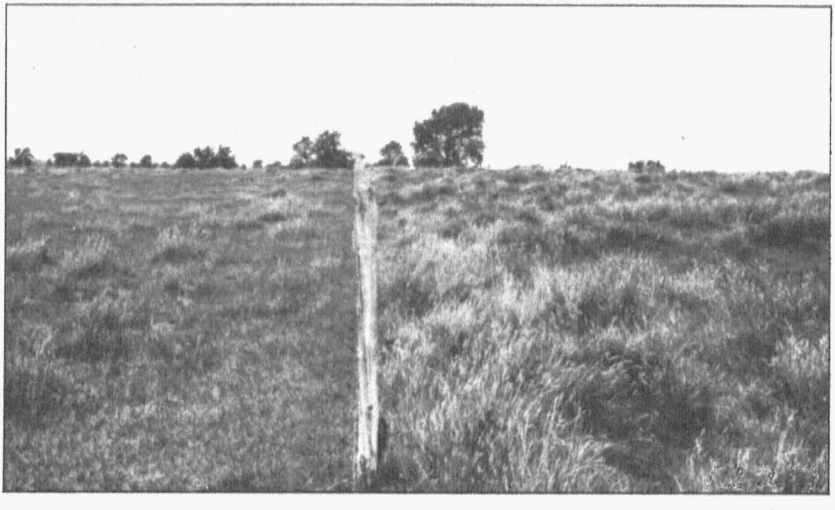
The field on which wheat and lespedeza were grown to be used exclusively for pasture was the most erodible field in the experiment, but soil loss was obviously negligible during the 5-year period of this investigation, although no actual measurement of soil loss was made.

## PART II.—THE IMPROVEMENT OF PERMANENT PASTURES WITH LEGUMES, PHOSPHATE, AND LIMESTONE

### Treatment and Seeding of the Bluegrass Pastures

An 8-acre block of established Kentucky bluegrass was fenced into four 2-acre pastures, the subsequent treatment of which differed as follows:

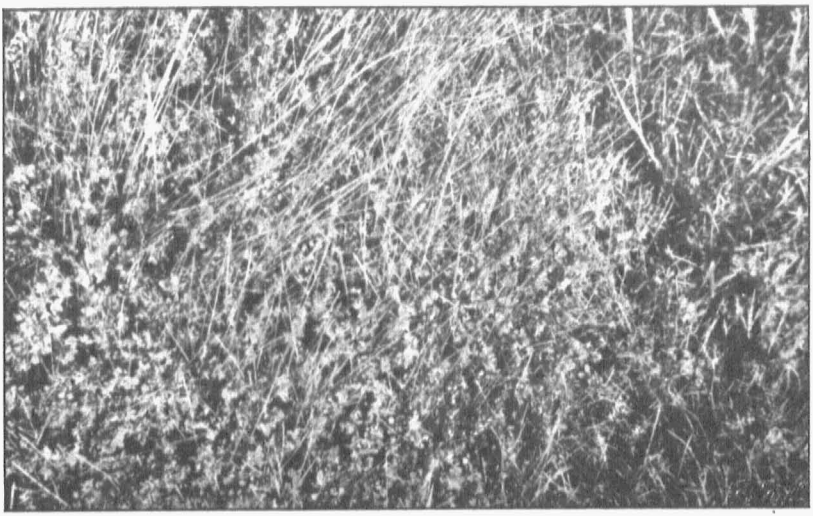
Pasture A. No legume was planted in this pasture—the check—and no fertilizer or limestone was applied to it.



Pastures A (left) and D (right), June 30, 1943. The larger quantity of grass in pasture D was due to its more vigorous growth and not to lighter grazing, for pasture D had carried 74 per cent more cattle per acre than pasture A since April 15.

Pasture B. Korean lespedeza was seeded in the bluegrass sod at the rate of 25 pounds per acre in March, 1939, again at the rate of 18 pounds per acre in January, 1940, and finally at the rate of 25 pounds per acre in January, 1941. No fertilizer or limestone was applied.

Pasture C. Korean lespedeza was sown here at the same times and rates as in pasture B, and in addition unhulled sweet clover was seeded at the rate of 25 pounds per acre in March, 1943. Agricultural limestone was applied at the rate of 3 tons per acre in December, 1938, and at the rate of 2 tons per acre in December, 1940. Phosphate fertilizer was drilled into the grass sod at the rate of 300 pounds of 0-20-0 per acre in March, 1939, and again at the same rate in March, 1944.



Korean lespedeza and bluegrass in pasture B, September 17, 1942.

Pasture D. Sweet clover was seeded in this pasture at the following rates and periods: 20 pounds of scarified seed per acre in March, 1939; 30 pounds of unhulled seed per acre in March, 1940; 25 pounds of unhulled seed per acre in January, 1941; and 25 pounds of unhulled seed per acre in March, 1944. Phosphate fertilizer and agricultural limestone were applied to pasture D at the same periods and rates as in pasture C.

All 4 pastures were occupied initially by uniformly dense swards of bluegrass in which there was almost no white clover or other legumes and in which the weed and wild grass content was small. Although the untreated soil was sufficiently fertile to maintain a dense stand of bluegrass, a deficiency of available nitrogen was evidenced by the light color and unthrifty growth of the grass.

Satisfactory stands of both Korean lespedeza and sweet clover resulted from the 1939 seeding, but severe drought during the late spring and early summer of that year destroyed the seedlings of both legumes growing in the bluegrass sod and made it necessary to reseed them in the spring of 1940. Although dry weather during the late summer and fall of 1940 retarded the growth of both the lespedeza and the bluegrass and reduced the production of lespedeza seed, the reseeding of this legume in 1941 was probably unnecessary, but was done to insure a uniform stand of lespedeza in the bluegrass sod. Sweet clover was seeded again in 1941 because a satisfactory stand of it had not been obtained in the middle one-third of pasture D from either of the previous seedings. Sweet clover was sown in pasture D, again in 1944, because sweet clover had not been reestablished in this pasture during 1943 by natural reseeding.

The second application of limestone at the rate of 2 tons per acre to pastures C and D was made in December, 1940, because evidence of a slight lime deficiency was found in the middle one-third of pasture D, where sweet clover failed in 1940. This lime deficiency in the surface 6 inches of soil was probably due to slow penetration of the surface applied material into the soil and indicates the advisability of drilling a part of the limestone into grass sod in which sweet clover is to be established. The initial 3-ton application of limestone was certainly adequate for lespedeza, and probably was enough to meet the requirements of sweet clover, if given sufficient time to penetrate the soil.

### Grazing Management of the Permanent Pastures

Cattle were removed from pasture D from May 5 until July 19 during 1940, in order not to injure the first-year sweet clover that had been successfully established over approximately two-thirds of its total area. With this one exception, grazing during the first 3 years (1940 to 1942) was continuous on each of the 4 pastures until the termination dates shown in Table 2. The intention during the first 3 years was to make full use of the available pasturage during the spring and early summer while it was most palatable and most nutritious and then to move the cattle to supplementary pastures of Korean lespedeza that followed wheat or oats harvested for grain. An overestimation of the carrying capacity of pastures A and B resulted in the early removal of cattle from them in 1940, and an underestimation of

the productivity of all 4 pastures resulted in their being undergrazed during 1941 and 1942, even though the period of grazing was extended to the end of July.

Sweet clover and bluegrass in pasture D, June 28, 1944.

The above system of grazing was continued on pastures A and B during 1943 and 1944, but results obtained during the first 3 years from pasture D indicated that it was not practicable to maintain a balanced stand of first-year and second-year sweet clover in the same bluegrass pasture. A grazing schedule that made full use of the bluegrass and associate second-year sweet clover at a time when they were most palatable and most nutritious, weakened or destroyed the first-year sweet clover; and a grazing schedule that promoted the growth of first-year sweet clover, made inefficient use of the bluegrass and second-year sweet clover. Because of this, sweet clover was seeded in pasture C in 1943, and during that and the following year, pastures C and D were managed so that the pasture that contained first-year sweet clover was pastured during late April and early May until the sweet clover seedlings were tall enough to be bitten off, after which it was not grazed until July, when the sweet clover plants had grown to an average height of 12 inches. The bluegrass and first-year sweet clover was then pastured moderately from the first half of July to the first of September, when the

cattle were again removed and kept off until the sweet clover top-growth had been killed by freezing. The pasture that contained second-year sweet clover, on the other hand, was grazed heavily during the spring and early summer until July, by which time the first-year sweet clover in the other pasture had made enough growth to withstand moderate grazing. After September 1, the bluegrass in which second-year sweet clover had matured seed was again grazed heavily until cold weather, not only to utilize fully the available bluegrass but to reduce somewhat the competition that the grass would offer to sweet clover seedlings during the succeeding year.

The grazing periods listed in Table 2 for pastures C and D during 1943 and 1944, show that when 2 bluegrass pastures in which first-year and second-year sweet clover alternate are grazed in this manner, one almost exactly supplements the other so that cattle could be carried continuously from early spring to midwinter on permanent pasture without the use of supplementary pastures. This would be advantageous on farms that include an inadequate acreage of crop land.

### Comparative Gains in Weight Made by Beef Cattle on the Differently Treated Bluegrass Pastures

Gains in weight by the cattle that grazed the differently treated bluegrass pastures during 1939 were not measured, but the annual live-weight gains made in each pasture by 2-year-old beef steers without supplemental feeding during the 5-year period, 1940 to 1944, are recorded in Table 3.

The average annual gain in weight per acre made by beef cattle during the 3-year period (1940-1942) on pasture B, in which Korean lespedeza was established and maintained, without the addition of fertilizer or lime, was 37 per cent larger than the gain made by comparable cattle on pasture A, in which no legume was seeded, and in which legumes did not volunteer in significant quantity until late in the summer of 1944. During the same 3-year period, gains made per acre by beef cattle on pasture C, which, in addition to the establishment of Korean lespedeza in the grass, received applications of phosphate fertilizer and limestone, exceeded gains obtained from pasture A by 60 per cent. Beef cattle gains obtained during the entire 5-year period (1940-1944) from pasture B were 55 per cent

larger than the gains obtained from pasture A over the same period.

The largest live-weight gains in weight by beef cattle per acre were made on the bluegrass seeded to sweet clover, during those years when second-year plants of sweet clover predominated (pasture C in 1944; pasture D in 1941, 1942) or when there was no sweet clover (pasture D in 1943) so that full use could be

TABLE 3. - LIVE-WEIGHT GAINS MADE BY BEEF CATTLE ON DIFFERENTLY TREATED KENTUCKY BLUEGRASS PASTURES, AT LATHROP.

| Pasture and its treatment | Pounds gain per acre | | | | | 5-year average |
|---|---|---|---|---|---|---|
| | 1940 | 1941 | 1942 | 1943 | 1944 | |
| A. Ky. bluegrass - no legume no soil treatment | 150 | 97 | 105 | 50 | 100 | 100 |
| B. Ky. bluegrass-Korean lespedeza - no soil treatment | 170 | 138 | 175 | 90 | 205 | 155 |
| C. Ky. bluegrass-Korean lespedeza - sweet clover (1) limed and phosphated (2) | 172 | 192 | 198 | # 140 | ## 222 | 185 |
| D. Ky. bluegrass - sweet clover limed and phosphated (2) | # 97 | ## 238 | ## 222 | ## 160 | # 130 | 169 |

\# - Grazing management for first-year sweet clover.
## - Grazing management for second-year sweet clover
(1) - Sweet clover first seeded in pasture C during March 1943
(2) - Agricultural limestone was applied at the rate of 3 tons per acre in 1938 and at the rate of 2 tons per acre in 1940.
Fertilizer (0-20-0) was applied at the rate of 300 pounds per acre in 1939 and 1944.

made of the available pasturage during the spring and early summer when it was most palatable and most nutritious. Smaller gains were made by the cattle on pasture D during 1940 and 1944, because it was not pastured during the greater part of May and all of June in order to protect the first-year sweet clover from the injurious effects of grazing. Limiting the spring and early summer grazing to preserve the stand of first-year sweet clover in pasture C during 1943 did not reduce so greatly the gain in weight obtained from that pasture because of the presence there of Korean lespedeza that supplied much good quality pasturage during the latter half of July and all of August, when this pasture was grazed.

The average annual gain in weight per acre made by cattle on the bluegrass pastures that were improved with sweet clover plus phosphate fertilizer and lime (pasture C, 1943 and 1944, and pasture D, 1940 to 1944) was 173 pounds, or 73 per cent above that obtained from unimproved pasture A.

Somewhat larger gains in weight probably would have been obtained from all 4 pastures if they had been grazed more intensively, particularly during 1941 and 1942. Heavier grazing probably would not have reduced, but might have increased, the difference in the productivity of improved and unimproved pastures, because a larger amount of surplus pasturage accumulated in the improved pastures than in pasture A.

The comparatively small gains obtained from all pastures during 1943 was due to the continuous snow cover that prevented pasturing off during the winter the old grass that had accumulated during the late summer and fall of 1942. The cows that were turned in to graze the residue of grass during the first half of April, ate also the new growth, and the grass did not recover during the remainder of 1943 from the adverse effect of this early over-grazing.

### Plant Counts in the Differently Treated Pastures

Plant counts* were made in each of the 4 differently treated bluegrass pastures in order to determine with what degree of success lespedeza and sweet clover had been established in the sod and to determine the effect of the legumes and soil treatments on the density of the bluegrass sward and its invasion by weeds, weed grasses, or legumes other than those that had been intentionally planted.

By the method of counting used in this experiment, no more than 100 hits per 100 points could be scored on any one class of plants. The number of hits per 100 points recorded for each class of plants in Tables 4, 5 and 6 approximately represent the percentage of a perfect stand of each. Although 100 hits per 100 points would not necessarily indicate a maximum stand for that class of plants, it would mean that the stand was uniformly dense.

*Plant counts were made with a point quadrate similar to that described by Fred W. Tinney, O. S. Aamodt and Henry L. Ahlgren, "Preliminary Report of a Study on Methods Used in Botanical Analyses of Pasture Swards", Journal of the American Society of Agronomy, Vol. 29; 835-840; October, 1937. The method was modified so that only one hit per point was counted for each plant class touched as a point was pushed to the ground, even if repeated hits were made on that same class of plants by that point before it reached the ground. A hit on bare ground was recorded when a point was pushed to the ground without touching a plant.

The data in Table 4 show the effect of sod tillage on the initial establishment of the seeded legumes in the bluegrass pastures. The south one-half of each of the 4 pastures was double-disked during November, 1939, and the legume seedings were made on both the disked and the untilled portions of each pasture during the following spring.

TABLE 4. - COMPARATIVE STANDS OF LEGUMES, KENTUCKY BLUEGRASS, WEED GRASSES, AND WEEDS IN DIFFERENTLY TREATED PERMANENT PASTURES AT LATHROP, AUGUST 27, 1940.

| Pasture | | Hits per 100 points | | | | |
|---|---|---|---|---|---|---|
| | | Seeded legume | Other legumes | Bluegrass | Weeds and weed grasses | Bare ground |
| A | not disked | | trace | 88 | 4 | 12 |
| | disked | | 0 | 86 | 4 | 12 |
| | average | | trace | 87 | 4 | 12 |
| B | not disked | 37 | 0 | 94 | 2 | 3 |
| | disked | 76 | 0 | 67 | 0 | 2 |
| | average | 56 | 0 | 80 | 1 | 3 |
| C | not disked | 19 | 0 | 95 | 8 | 3 |
| | disked | 43 | 0 | 84 | 0 | 7 |
| | average | 31 | 0 | 90 | 4 | 5 |
| D | not disked | 23 | 9 | 85 | trace | 7 |
| | disked | 32 | 7 | 82 | 0 | 11 |
| | average | 28 | 8 | 84 | trace | 9 |

A - No legume seeded, no soil treatment
B - Korean lespedeza seeded, no soil treatment
C - Korean lespedeza seeded 0-20-0 fertilizer and limestone applied.
D - Sweet clover seeded; 0-20-0 fertilizer and limestone applied.

The stand of each legume that resulted from the 1940 seeding was roughly proportional to the reduction in the stand density of the bluegrass by disking. The greater effectiveness of the disking in pasture B was due to a rain that fell after the other pastures had been disked and before the disking of the south half of pasture B.

Comparative stands of legumes, bluegrass, weeds, and the percentage of the ground surface that was not covered by any plants for each of the 5 years from 1940 to 1944, except 1943 when no counts were made, are shown by the data in Table 5. The specific legumes grouped under the headings of "seeded legumes" and "other legumes" in Table 5 are listed separately in Table 6. The results presented in Table 4 demonstrate the advisability of sod scarification by means of a disk or some other suitable tool when lespedeza or sweet clover are to be seeded in dense swards of

bluegrass. The initial establishment of from 19 to 37 per cent of a full stand of Korean lespedeza in a dense, untilled sod of Kentucky bluegrass and the reestablishment after 1940, of medium to good stands of lespedeza in the dense bluegrass swards of pastures B and C without additional tillage, indicate, however, that sod scarification is not essential either for the initial establishment of this legume in bluegrass, or for its annual reestablishment, if grazing is correctly managed. The comparatively sparse stand of lespedeza that remained in pasture B by September 25, 1944, was due to a deterioration in the stand that apparently

TABLE 5. - COMPARATIVE STANDS OF LEGUMES, KENTUCKY BLUEGRASS, WEED GRASSES, AND WEEDS IN DIFFERENTLY TREATED PERMANENT PASTURES AT LATHROP.

| Date | Pasture | Hits per 100 points | | | | | |
|---|---|---|---|---|---|---|---|
| | | Seeded legumes | Other legumes | Kentucky bluegrass | Weed grasses | Weeds | Bare ground |
| 1940 Aug. 27 | A | | trace | 87 | 4 | | 12 |
| | B | 56 | 0 | 80 | 1 | | 3 |
| | C | 31 | 0 | 90 | 4 | | 5 |
| | D | 28 | | 84 | trace | | 9 |
| 1941 June 26 | A | | 2 | 81 | trace | 0 | 19 |
| | B | 45 | trace | 78 | trace | 0 | 11 |
| | C | 22 | 0 | 76 | 1 | 2 | 19 |
| | D | 52 | trace | 78 | 0 | trace | 8 |
| 1942 June 12 | A | | 5 | 89 | 0 | 1 | 9 |
| | B | 63 | 0 | 84 | 0 | 0 | 6 |
| | C | 40 | 0 | 88 | 0 | 0 | 5 |
| | D | 24 | 1 | 88 | 0 | 0 | 8 |
| 1944 Sept. 25 | A | | 14 | 87 | 45 | 22 | 1 |
| | B | 18 | 2 | 92 | 16 | trace | 2 |
| | C | 22 | 1 | 96 | 2 | 6 | 2 |
| | D | 21 | 5 | 97 | 2 | 4 | 2 |

A - No legume seeded, no soil treatment
B - Korean lespedeza seeded, no soil treatment
C - Korean lespedeza seeded 1939-1941, sweet clover seeded 1943; 0-20-0 fertilizer and limestone applied.
D - Sweet clover seeded; 0-20-0 fertilizer and limestone applied.

resulted from continuous close grazing during August and September, a period of above average rainfall. The stand of lespedeza had been reduced by at least 60 per cent from July to late September, 1944, but more hits were scored on bluegrass during this final count than during any previous measurement of stand.

Although sweet clover proved to be very effective in increasing the productivity of pasture D, even during 1943, when there was almost no sweet clover in the grass sod, but when the residual effect of added nitrogen was clearly evidenced by the vigor and dark green color of the grass, its reestablishment in bluegrass sod was less dependable than that of lespedeza. Some form of sod tillage may be required in alternate years in order to maintain an adequate stand of sweet clover in permanent pastures.

TABLE 6. - COMPARATIVE STANDS OF DIFFERENT LEGUMES IN THE DIFFERENTLY TREATED PERMANENT PASTURES AT LATHROP.

| Date | Pasture | Hits per 100 points | | | |
|---|---|---|---|---|---|
| | | Korean lespedeza | First-year sweet clover | Second-year sweet clover | White clover |
| 1940 Aug. 27 | A | TRACE | 0 | 0 | 0 |
| | B | 56 | 0 | 0 | 0 |
| | C | 31 | 0 | 0 | 0 |
| | D | 8 | 28 | 0 | 0 |
| 1941 June 26 | A | 2 | 0 | 0 | 0 |
| | B | 45 | 0 | 0 | trace |
| | C | 22 | 0 | 0 | 0 |
| | D | trace | 38 | 14 | 0 |
| 1942 June 12 | A | 5 | 0 | 0 | 0 |
| | B | 63 | 0 | 0 | 0 |
| | C | 40 | 0 | 0 | 0 |
| | D | 1 | 9 | 15 | 0 |
| 1944 Sept. 15 | A | 12 | 0 | 0 | 2 |
| | B | 18 | 0 | 0 | 2 |
| | C | 17 | 1 | 4 | 1 |
| | D | 4 | 14 | 3 | 1 |

A - No legume seeded, no soil treatment.
B - Korean lespedeza seeded, no soil treatment.
C - Korean lespedeza seeded 1939-1941, sweet clover seeded 1943; 0-20-0 fertilizer and limestone applied.
D - Sweet clover seeded; 0-20-0 fertilizer and limestone applied.

The data in Table 5 show further that the stand density of bluegrass was increased as a result of introducing either lespedeza or sweet clover into the pasture sward. Furthermore, during 1944, the only year in which important quantities of weeds invaded any of these pastures, there was much less weed grass and fewer weeds in the pastures that had been improved by the seeding of legumes than there were in pasture A, in which the 12 hits made on lespedeza and the 2 hits made on white clover represent its maximum legume content from 1938 to 1944.

## SUMMARY


### Part I.—One-Year Rotations of Grain and Korean Lespedeza for Northwestern Missouri

1. The double cropping systems compared were: (a) Winter barley for grain and Korean lespedeza for hay; (b) oats for grain and Korean lespedeza for pasture; (c) wheat for grain and Korean lespedeza for pasture; and (d) wheat and Korean lespedeza, both crops used entirely for pasture.

2. The average annual production per acre of each 1-year rotation during the 5-year period, 1940 to 1944 inclusively, was: (a) 15 bushels of barley plus 2 tons of lespedeza hay; (b) oats 36 bushels plus 68 pounds gain made by beef cattle on the lespedeza pasture (during 3 years 1940 to 1942 after which this system was discontinued); (c) 15 bushels of wheat plus 112 pounds gain made by beef cattle pastured on the lespedeza; and (d) 275 pounds gain by beef cattle that pastured both the wheat and the lespedeza.

### Part II.—The Improvement of Permanent Pastures with Legumes, Phosphate and Limestone

1. The following methods of improving old bluegrass pastures were compared: (a) Seeding Korean lespedeza in the grass sod without soil treatment; (b) seeding Korean lespedeza in bluegrass sod to which 0-20-0 fertilizer and limestone had been applied; and (c) seeding sweet clover in bluegrass sod to which 0-20-0 fertilizer and limestone had been applied.

2. The average annual live-weight gains made by beef cattle per acre of each of the differently treated permanent pastures over the 5-year period, 1940 to 1944 were: (a) no treatment, 100 pounds; (b) seeded to Korean lespedeza without soil treatment, 155 pounds; (c) seeded to Korean lespedeza 1940 to 1942 and to sweet clover 1943 and 1944, and limed and phosphated, 185 pounds; and (d) seeded to sweet clover and limed and phosphated, 169 pounds.

3. Establishing sweet clover in the bluegrass sward resulted in a larger production of dry matter than the establishment of a comparable stand of lespedeza, but the necessity of deferring the grazing during most of May and all of June whenever sweet clover was being reestablished, prevented the most efficient use

of the available forage during those years and reduced the average annual cattle gains obtained.

4. Disking this dense bluegrass sod increased the initial stands of both lespedeza and sweet clover that resulted from sowing each of these legumes in old pastures. No further tillage was required to maintain an adequate stand of lespedeza in the bluegrass under correct grazing management, but the results indicated more than correct management of grazing might be required for the reestablishment of sweet clover in the bluegrass in alternate years.

5. The presence of lespedeza or sweet clover in the bluegrass sward not only increased its productivity, but also increased the stand density of the bluegrass and retarded the invasion of the sward by weeds and weed grasses during a wet summer.