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ORCHARD GRASS SOD IN THE OZARKS

Grass Investigations in the Ozark Upland

First Report

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Agricultural Experiment Station

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(2) In the service of the U. S. Department of Agriculture.

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ILLUSTRATIONS

GRASS INVESTIGATIONS IN THE OZARK UPLAND

M. F. MILLER AND C. B. HUTCHISON

The production of pasture grasses is destined to be one of the most important features of the agriculture of the Ozark region. Naturally, in a region with such a wide diversity of soils there is likewise a great diversity of agriculture, but the fact remains that the larger part of the region is best suited to grazing purposes. Unfortunately, there is considerable difficulty experienced in producing satisfactory pastures on large areas of this region, due, in some cases, to the dry, gravelly or rocky soil and, in others, to the undergrowth, while often both difficulties are encountered on the same land. The problem for the greater part of the region which is now in timber, however, is that of the undergrowth and when this can be controlled, the production of fair pastures is usually possible. It cannot be said that any considerable part of this region is a natural grass country as compared with the best bluegrass regions of the state and the larger share of the land will never be suited to intensive grazing, but with a proper control of the undergrowth and a proper handling of the grass lands, profitable pastures can be produced.

On certain lands, it is undoubtedly true that the production of timber will remain the most profitable industry, and the recommendations regarding pasture management, which are here made, should in no sense be taken to mean that the entire region will ever be cleared and pastures established. As a matter of fact, the establishing of tame grass pastures over any considerable proportion of this timbered upland will require much time, and it will be economically possible in most cases only after a development of transportation facilities has made a more intensive agriculture practicable. There are, of course, men who can make this possible on an extensive scale regardless of the development of transportation lines, where the soil is well suited to grass growing, but as a rule the good tame pastures will be associated with a somewhat more intensive system of farming than is generally common in this region. There are certain areas of this region which are naturally well suited to general agriculture and the production of hay and grain. With the exception of a few special fruit growing areas, however, the handling of livestock should form an important part

of practically every system of farming in this region. The problem of establishing profitable pastures throughout the Ozark region, therefore, consists first, in getting rid of the undergrowth where this interferes, and second, in adopting proper systems of pasture management. Many farmers have already solved these problems for their own localities, but on the whole, information regarding the various aspects of this problem is not widely distributed nor are the best methods employed on any great per cent of the farms. Realizing the need of specific information along these lines the Agricultural Experiment Station some years ago began a systematic investigation for the purpose of finding out the facts and of getting these facts to the people.

PLAN OF INVESTIGATION

The general plan of these experiments divided itself into two parts, first, field experiments with grass and clover varieties and with methods of pasture management, in various parts of the Ozark region, and second, a special investigation of the methods practiced by the best farmers of this territory. The field experiments were begun in the spring of 1907 and have been continued until the present time. These experiments have been carried out in cooperation with farmers, the Station furnishing the seeds and other material, the farmers doing the work of seeding and caring for the experiment. The exact plan of the experiment has varied from time to time but the following is representative:

	MANURE	BONE MEAL	DRIED BLOOD	LIME	NO TREATMENT
Timothy	:	:	:	:	:
	:	:	:	:	:
Kentucky Bluegrass	:	:	:	:	:
	:	:	:	:	:
Orchard Grass	:	:	:	:	:
	:	:	:	:	:
Red top	:	:	:	:	:
	:	:	:	:	:
Tall meadow oat grass	:	:	:	:	:
	:	:	:	:	:
Smooth brome grass	:	:	:	:	:
	:	:	:	:	:
Meadow fescue	:	:	:	:	:
	:	:	:	:	:
Sheep's fescue	:	:	:	:	:
	:	:	:	:	:
Bermuda grass	:	:	:	:	:
	:	:	:	:	:
Red clover	:	:	:	:	:
	:	:	:	:	:
Alsike clover	:	:	:	:	:
	:	:	:	:	:
Mammoth clover	:	:	:	:	:
	:	:	:	:	:
White clover	:	:	:	:	:
	:	:	:	:	:
Mixture No. 1	:	:	:	:	:
	:	:	:	:	:
Mixture No. 2	:	:	:	:	:
	:	:	:	:	:
Mixture No. 3	:	:	:	:	:
	:	:	:	:	:

The soil selected for these experiments has been the average upland of the region, so far as possible, care being taken to get land that is uniform in character. The grass plots are usually 1/10 acre in size, laid out rather long and narrow. The land is plowed or otherwise worked up and the soil treatment given across all of the grass plots as shown in the sketch, after which the seed is very lightly harrowed in. The rates of seeding are ample for a good stand and cattle are kept off the plots at least the first year. No weights of hay have ever been taken as this is almost purely a pasture study. The eye is depended upon entirely in judging the comparative values of the various grasses or mixtures. The idea in using the soil treatments is to determine the desirability or necessity of such treatments in securing profitable pastures. The bonemeal is used because many of the soils of this region are low in phosphorus, the dried blood because of the low nitrogen supply of many of the soils and because grasses are particularly susceptible to nitrogen fertilization. The lime is used as a soil sweetener and the manure as an all-round fertilizer.

RESULTS OF EXPERIMENTS

Twenty experiments were started, but owing to failures due to weather conditions, etc., accurate results were secured from only fifteen of these. It has not been deemed advisable to give the complete data from each experiment, but merely a summary of the important observations and results.

Experiment with Rich Lucas, Mountain View, Howell County.

This experiment was begun in the spring of 1909 on average upland of the Vienna Group of soils near Mountain View. The plan of the experiment included the testing of red top, tall meadow oat grass, orchard grass, Canada bluegrass, Kentucky bluegrass, bromus inermis, red fescue, bermuda grass and a mixture of orchard grass, red top and mammoth clover. One half of each plot was manured with stable manure and the other half left unmanured. During the season of 1909 the grasses made a satisfactory growth. In 1910 and 1911 the grasses were pastured some but did well.

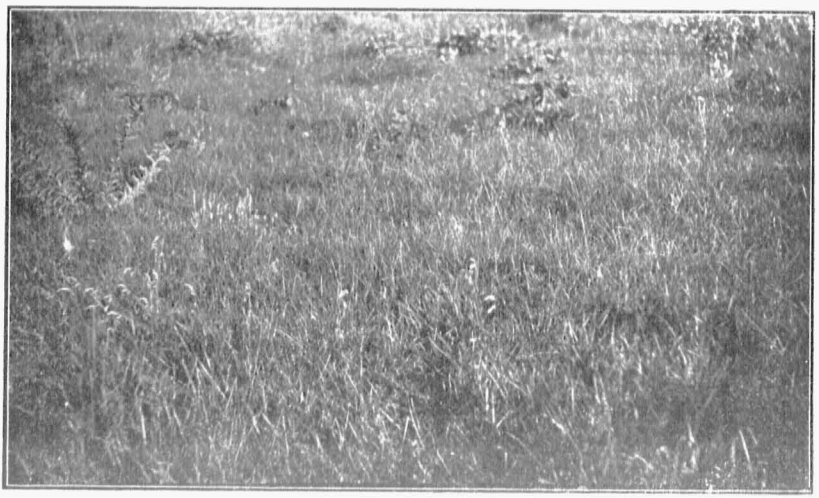
As a general summary of the results of this experiment it can be said that bluegrass, orchard grass and red fescue among the grasses tested were much the best. Red fescue, however, seemed to suffer more from pasturing than either of the other two. Red

top also did fairly well and will doubtless make good pasture grass in mixtures.

No very striking differences were observed between the manured and unmanured parts of the plots, but Kentucky bluegrass and tall meadow oat grass, responded best to the manuring.

Experiment with Ed Piquet, Dixon, Pulaski County.

The experiment on the farm of Ed Piquet at Dixon was located on the average upland of this section, on the Vienna group of soils. The land had not been farmed but had been cleared only a short time. The experiment included the testing of Kentucky bluegrass, red top, timothy, tall meadow oat grass, smooth brome grass, meadow fescue, perennial rye grass, orchard grass and bermuda grass, together with red clover, alsike clover, white clover and finally a plot including a mixture of all grasses and clovers, except the rye grass, bermuda grass and red top. The plots were one-tenth acre in size and the land was fairly uniform. The land was plowed in the spring of 1906 and after applying bone meal to one strip cross-wise of all plots, blood meal to another, lime to another and, leaving one strip untreated, the grasses and clovers were sown and lightly harrowed in. A good stand was secured on practically all plots. The plots were fenced and were not pastured until the second year when they were all pastured rather closely.



Bluegrass sod on the grass experiment field at Brandsville. The Brandsville soil is deep and moist enough to grow bluegrass quite well.

On September 10, 1907, after the field had been standing two seasons, the following notes showed the results secured: bluegrass is a fair stand and seems to be thickening; red top is good, probably next to bluegrass in thickness of stand; timothy is fair but not very thick; tall meadow oat grass and smooth brome grass have a very thin stand; meadow fescue, perennial rye grass, orchard grass, red clover and alsike clover a scattering stand; white clover practically no stand; the mixture shows a fair stand although somewhat affected by dry weather and Japan clover is coming in. It is reported as having been good earlier in the season. It was also reported that there was quite a difference in favor of the blood, bone and lime plots over the check earlier in the season but it was not visible when these September notes were made.

The results of this experiment are by no means conclusive. The pasturing the second season seems to have been somewhat too close but it can be said that bluegrass, red top and timothy gave the best results among the grasses, while orchard grass shows some promising results. Among the clovers, the red clover was superior.

Experiment with W. D. Gibson, Dixon, Pulaski County.

The experiment with Mr. Gibson was located on the Vienna group of soils near Dixon. The experiment included the testing of the following grasses and clovers without the use of fertilizers: Kentucky bluegrass, red top, timothy, tall meadow oat grass, brome grass, meadow fescue, perennial rye grass, orchard grass, red clover, alsike clover and white clover, with one plot sown to a mixture of all of these. The ground was plowed and put in condition for sowing and the grasses were put in in the spring of 1906. The season the first year was fairly favorable and a fair stand was secured.

The bluegrass plot was plowed up in the spring of 1908 and all plots were pastured that year. Observations made in April 1908 were as follows: The red top made a good stand and grew well; the timothy was still good, although white clover was creeping in some; the tall meadow oat grass had a good growth and had begun stooling well; the brome grass was almost completely taken by white clover; the meadow fescue looked well but contained a good deal of white clover; the rye grass was poor, some white clover showing in it; the orchard grass had thickened up, making a splendid stand and looked fine; the white clover had practically taken

the place of the red and alsike clovers, while the white clover plot itself was not so good as the previous season. The mixture was very good, consisting of timothy, red top, bluegrass, orchard grass and white clover, the red clover having largely disappeared.

From these results, it will be seen that the grasses which did best are timothy, red top, tall meadow oat grass, bluegrass and orchard grass; while red, alsike and white clovers have done well.

Experiment with W. A. Smiley, Simmons, Texas County.

The experiment at Simmons was located in the Vienna group of soils on a rocky ridge which had been cleared in 1909. The plots were approximately one-tenth acre in size and the following grasses and clovers were sown in the spring of 1910: timothy, red top, Kentucky bluegrass, orchard grass, perennial rye grass, tall meadow oat grass, smooth brome grass, alsike clover, red clover, mammoth clover and white clover, together with the following mixtures: mixture No. 1, red clover, timothy and orchard grass; mixture No. 2, red clover, alsike clover, timothy, orchard grass and Canada bluegrass; mixture No. 3, red clover, alsike clover, white clover, timothy, orchard grass, Kentucky bluegrass and Canada bluegrass; mixture No. 4, was a mixture of all the grasses and clovers. The seeds were put in without plowing, the ground simply being harrowed after having been in corn the previous year.

On April 19th, 1911, the following observations were made as to the stand and character of the growth on the various plots: timothy had a stand of 70 per cent, red top 90 per cent, Kentucky bluegrass 50 per cent, Canada bluegrass 5 per cent, orchard grass 60 per cent, perennial rye grass 5 per cent, tall meadow oat grass 50 per cent, smooth brome grass 20 per cent, alsike clover 80 per cent, red clover 75 per cent, white clover 80 per cent, mixture No. 1, 80 per cent, mixture No. 2, 90 per cent, mixture No. 3, 95 per cent and mixture No. 4, 95 per cent. The 1912 report of this experiment field was incomplete, but Mr. Smiley says timothy, red top, and orchard grass were all well adapted to conditions there, while tall meadow oat grass and bluegrass were only fair. The clovers all did well.

Experiment with P. G. Smith, Poplar Bluff, Butler County

The experiment near Poplar Bluff was begun in the fall of 1907. The soil is the upland of that region, a yellowish brown clay loam of the Howell group of soils. The following grasses were sown:

orchard grass, timothy, red top, bromus inermis, meadow fescue, sheep's fescue, tall meadow oat grass, Kentucky bluegrass, crimson clover, red clover, alsike clover, white clover, Bokhara clover and alfalfa. In addition one plot was sown to a mixture of all these and another plot to a mixture of timothy, tall meadow oat grass, red top, sheep's fescue, red clover, alsike clover and white clover, which was designated as mixture No. 1, while another was sown to red top, red fescue, sheep's fescue, Kentucky bluegrass, alsike clover and red clover, this being designated as mixture No. 2. The grass plots were laid out in narrow strips twenty feet wide and 275 feet long, approximately one-tenth acre in each. Manure at the rate of 8 tons per acre was applied to a strip fifty feet wide running cross-wise of the grass plots, bone meal at the rate of 200 pounds per acre on a similar strip, dried blood at the rate of 200 pounds per acre on another and lime at the rate of 1000 pounds per acre on another, while a fifty foot strip was left without treatment.

The grasses were sown the 30th of September, which was a little late, even for that section of the state, and the stand was poor. The plots were, therefore, replowed and reseeded in the fall of 1908, a fair stand being secured.

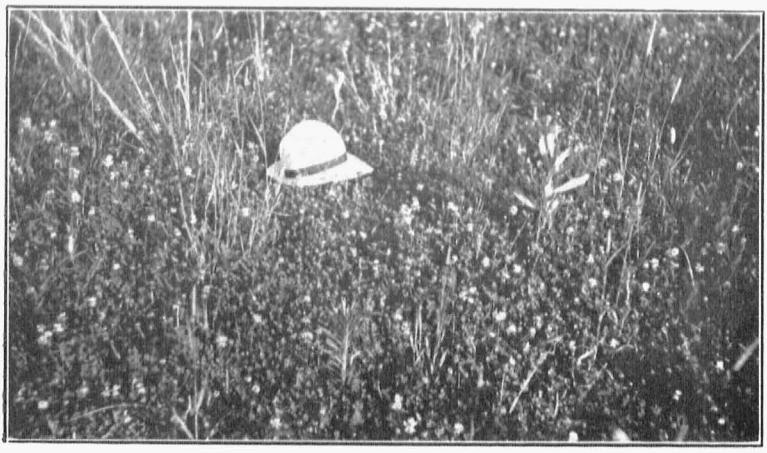
From the results of this trial it can be said, first, that the grasses doing best, without manuring, are red top, bluegrass, timothy, orchard grass and tall meadow oat grass, the red top doing by far the best after the second season. Second, that the common clovers such as red, alsike, mammoth and white are fairly well adapted but do very much better when the land is manured or treated with bone meal. Third, that the use of bone meal or barnyard manure will be very beneficial in seeding down grasses and clovers on this land.

Experiment with G. W. Ferguson, Brandsville, Howell County

The experiment at Brandsville was located on the average upland in this vicinity in the Howell group of soils. It was seeded in the fall of 1907 and included the following grasses and clovers: Kentucky bluegrass, tall meadow oat grass, bromus inermis, meadow fescue, orchard grass, red fescue, sheep's fescue, red clover, mammoth clover, alsike clover and Bermuda grass. These were sown in long narrow plots, each containing one-tenth acre, and the whole area was divided into five strips running crosswise of the grass plots. One of these strips received stable manure, an-

other dried blood, another bone meal, another lime, and another received no soil treatment. A good stand was secured.

The following observations on the experiment made at the end of the first year showed the condition of the various grasses at that time: Kentucky bluegrass had a fair stand over the entire plot, tall meadow oat grass had a fine stand over the entire plot, orchard grass was excellent with a heavy sod. Mammoth and red clovers were fine, with very heavy growths over the entire plots, while alsike clover had a fair stand, except on the limed areas. The other grasses were poor or had failed entirely, excepting Bermuda grass, which was fair. The grasses were neither pastured nor cut and were allowed to stand until the fall of 1909, when the following observations were made: The bluegrass showed a very good growth and had become somewhat mixed with Japan clover, which seemed to help rather than injure the grass. On the manured plot it produced much seed, but on the other plots little seed was produced. Tall meadow oat grass had a fairly good stand where manure had been applied. Upon the other areas the stand was uneven. Orchard grass had an excellent sod over the entire plot and showed little effect of manure or fertilizers. The Bermuda grass was doing no good. White clover was doing well. The red clover plot was uneven in stand except where the bone meal and manure were applied. The mammoth clover was best on the manured areas, but was good on the entire plot. The alsike clover was a good stand, especially on the bone meal plot, where a



White clover sod on the experiment field at Brandsville.

fine stand was secured. It showed as promising results for pasture as did the white clover. This alsike clover plot had some advantage, however, in the soil being slightly better than that of most of the others.

In summarizing the results of this experiment, it can be said that orchard grass and bluegrass are pre-eminently the best grasses for this soil, while tall meadow oat grass has also done fairly well. Among the clovers, the white and alsike seem best adapted for pasture, while the red clover will also grow well, particularly where the land is of fair fertility. The application of both manure and bone meal to this land will enhance the value of pastures.

Experiment with G. L. Sesson, West Plains, Howell County

The experiment at West Plains was put out on a piece of land belonging to the Howell group of soils, but which was really a type of valley land rather than of upland, the land having been farmed for a number of years. The experiment was seeded in the fall of 1907, using the following grasses and clovers: orchard grass, timothy, red top, tall meadow oat grass, meadow fescue, smooth brome grass, sheep's fescue, Kentucky bluegrass, red clover, mammoth clover, alsike clover, crimson clover and white clover. In addition the following mixtures were sown: mixture number 1, timothy, red top, tall meadow oat grass, sheep's fescue, red clover, alsike clover and white clover; mixture number 2, bluegrass, red top, red fescue, sheep's fescue, red clover and alsike clover; mixture number 3, a mixture of all.

The grass plots were approximately one-tenth acre in size. The land was divided into strips running crosswise of the plots and the following treatments given: one strip received manure, another bone meal, another dried blood, another lime, and another no treatment.

Owing to the very dry weather in the fall, the seeds did not come up until the following spring, when a very poor stand was secured. In the fall of 1908, however, observations showed that orchard grass, red top, timothy and tall meadow oat grass were doing well, while bluegrass had made a fair stand wherever it had been sown, especially where dried blood had been used. Red clover had made a good stand on the manured land, but failed elsewhere, while white clover was doing well wherever sown. In the mixtures, 1 and 3, tall meadow oat grass predominated with bluegrass, and clover next in importance. In mixture No. 2, bluegrass pre-

dominated, with red top and red clover following. The stand in general was so irregular that the land was re-plowed and re-seeded in the fall of 1908, but a poor stand was again obtained. In June of 1909, observations showed that the various grasses were showing sparingly. Orchard grass was the best. The plot was pastured in the autumn of 1909 and the spring of 1910. Observations in 1910 showed that bluegrass and some of the larger grasses, such as orchard grass and tall meadow oat grass, were doing well, but that there was little clover, except white clover, which seemed to be taking the entire plot. As to the effect of the fertilizer, it was noted both years that, in general, manure was best, with bone meal second, and some little results were received from dried blood, although lime seemed to help little.

The results of this experiment are not satisfactory, but indicate that orchard grass, bluegrass, tall meadow oat grass, timothy and red top among the grasses are the most satisfactory, with alsike and white clover among the clovers.

Experiment with D. M. Robertson, Doniphan, Ripley County

The experiment at Doniphan was established on a type of soil which would be known as valley land in the Howell group of soils, the soil being a clay loam and sloping toward a creek. This land had been farmed a number of years. It was prepared by plowing and harrowing several times. The plots were approximately one-tenth acre in size and the grasses were put in without any manuring or fertilizer treatment. The following grasses and mixtures were sown: red fescue, red top, meadow fescue, Kentucky bluegrass, tall meadow oat grass, bromus inermis, Canada bluegrass, orchard grass, and Bermuda grass. They were put out in the spring of 1909 and were allowed to grow until the fall of 1912, when the following observations were made: The red fescue had 80 per cent of a stand and was looking well; it grew rather slowly at first, but thickened up the second year, and indicated that it might be a valuable grass in a mixture on this land. The red top had 90 per cent of a stand and grew fairly well, but was best on the places in the plot which tended to be wet or spouty. The meadow fescue had 75 per cent of a stand with quite a good growth, and it seems fairly well adapted to this soil. The Kentucky bluegrass had 25 per cent of a stand, only a few plants surviving the first summer. It had a tendency to spread thereafter, however, and Mr. Robertson thinks that it is particularly adapted to north hill slopes where

the soil is more moist and contains more organic matter. The tall meadow oat grass had 75 per cent of a stand and had a fair growth, but with a small amount of blades, showing that it was not particularly suited as a pasture grass for this land, although it might be advisable in mixtures. The bromus inermis died out the first summer, and the Canada bluegrass failed to catch. The orchard grass had 95 per cent of a stand, a very rank growth with a thick turf and seems exceedingly well adapted to this soil. The Bermuda grass grew well from the start and spread rapidly. Mr. Robertson used cuttings from this patch and now has it growing over a good deal of the farm. He thinks that it is the most valuable grass he has.

Experiment with L. L. Luthy, Lebanon, Laclede County

The Experiment at Lebanon was located on a typical black oak upland, sloping slightly to the south, the land having been farmed for several years preceding the laying out of the experiment. The soil was rather compact and somewhat low in organic matter, belonging to the Lebanon group of soils. The field was divided into one-tenth acre plots, the land plowed and the following grasses seeded in the spring of 1907: Kentucky bluegrass, red top, timothy, tall meadow oat grass, smooth brome grass, meadow fescue, orchard grass, red fescue, sheep's fescue, red clover, mammoth clover, alsike clover, white clover and Bokhara clover. In addition, three mixtures were sown: No. 1 consisted of timothy, red top, tall meadow oat grass, sheep's fescue, red and alsike clover; No. 2 consisted of red top, blue grass, red fescue, sheep's fescue, red and alsike clover; No. 3 consisted of a mixture of all the grasses and clovers used on the field. Before sowing the grasses, the land was divided into strips running crosswise of the grass plots and treated with lime, bone meal, dried blood and barnyard manure respectively on four of the strips, while one strip was left untreated. A fine stand was secured.

On August 5, 1908, the following observations were made: bluegrass, timothy and red top made fair stands with the effects of the soil treatments ranking as follows: manure, bone meal, dried blood and lime. The tall meadow oat grass was good on the manured land and fair on all except the limed and untreated strips. The meadow fescue did some good on the manured plot, but failed on the others; the same can be said of the orchard grass. Red and mammoth clover were both good on all the plots, but best on the

A comparison of red top and timothy on the grass experiment field on the uplands at Poplar Bluff. The red top is thick on the ground and keeps down the white top which the timothy fails to do. Red top sod on the right, timothy on the left.

manured land, with bone meal showing the next benefit, dried blood the next, and the lime showing no benefit. The alsike clover did fairly well on the manured land and that receiving bonemeal, but practically failed on the others. The white clover came on and did fairly well on the land receiving bone meal, very poor on that receiving manure, and failed elsewhere. The Bokhara clover did well on the manured land, but failed elsewhere. All three mixtures did well and formed a good sod, especially on the land treated with manure and bonemeal, consisting mainly of timothy, tall meadow oat grass, orchard grass and red clover.

From these observations, the grasses which seem to be best suited to this soil are timothy, red top, bluegrass, tall meadow oat grass, and orchard grass, while red and mammoth are the best adapted of the clovers. The use of manure and bone meal would help very materially in securing a profitable pasture.

Experiment with Fred Oetting, Mansfield, Wright County

The experiment at Mansfield was put out on typical upland of the Lebanon group of soils in the spring of 1911, the following clovers and grasses being used: timothy, red top, English rye grass, Kentucky bluegrass, Canada bluegrass, orchard grass, red clover,

alsike clover and white clover, together with the following mixtures: mixture No. 1, orchard grass, timothy and red clover; mixture No. 2, orchard grass, Canada bluegrass, red and alsike clover; mixture No. 3, orchard grass, Kentucky bluegrass, Canada bluegrass, timothy, red alsike and white clover; mixture No. 4, a mixture of all. The drought of 1911 was hard on the young grass and clover, but all of them came through with at least a partial stand. Observations made in October, 1912, show that orchard grass stands out as the hardiest grass, with red top next, and timothy third. Mr. Oetting reports in his general statement that the orchard grass was excellent and that the red top was extra good, while timothy would be called good. He also states that he has tried bromus inermis and that it needs stronger land than that on which this experiment was tried. He states further that he sowed at the same time these grasses were sown, on new ground, under wheat, a mixture of orchard grass, bromus inermis, bluegrass, alsike and mammoth clovers, together with three and one-half acres under oats with the same mixture, exclusive of the mammoth clover. He reports that the orchard grass did by far the best among these grasses, which corroborates the finding on the experiment field. Evidently from this experiment, grasses like orchard grass and red top, mixed with red or white clover, would be satisfactory here.

Experiment with C. C. Blackwell, Melzo, Jefferson County

The experiment at Melzo was put out on average upland of the Reynolds group of soils in the spring of 1911, the ground being plowed and harrowed in preparing it for the seed. The following grasses and clovers were sown: timothy, red top, Kentucky bluegrass, Canada bluegrass, orchard grass, perennial rye grass, tall meadow oat grass, smooth brome grass, alsike, mammoth and white clover, together with the following mixtures; mixture No. 1, orchard grass, timothy and red clover; mixture No. 2, orchard grass, Canada bluegrass, red and alsike clovers; mixture No. 3, orchard grass, Kentucky bluegrass, Canada bluegrass, timothy, red, alsike and white clovers; mixture No. 4, a mixture of all.

The seeds came up well but the dry summer of 1911 killed most of them so that little was to be seen in the fall of that year. In April, 1912, observations showed that orchard grass and red clover were the only ones left, while mixtures No. 1 and No. 2 had about one-third of a stand, consisting mostly of orchard grass. In the fall of 1912, Mr. Blackwell reported that the grasses surviving

last year's drought were doing nicely and that there was practically no change to be reported from that given in the spring. He also reports that during the spring of 1910 he sowed fifteen acres of rough land to a mixture of grasses, mostly orchard grass, and that he had a good pasture during the dry summer of 1911 and that it is much ahead of any pasture in the locality. On this field, orchard grass is predominating. While these trials are not conclusive, they show the hardiness of orchard grass for this section.

Experiment with J. L. McCormick, Cuba, Crawford County

The experiment at Cuba was placed on a piece of Ozark prairie land in the Owensville group of soils. The soil was a dark loam, friable and of good appearance. Twelve one-tenth acre plots were laid out on uniform soil, the land prepared by plowing and harrowing and the grasses sown in the spring of 1906. The following grasses and clovers were used: Kentucky bluegrass, red top, timothy, tall meadow oat grass, smooth brome grass, meadow fescue, perennial rye grass, orchard grass, alsike clover, white clover, a mixture of meadow fescue and alsike clover and a mixture of all except red top. Before seeding, the field was laid off in strips cross-wise of the grass plots and the following applications given: lime, bone meal, dried blood and one strip, both bone meal and lime.

Orchard grass sown with a thin seeding of oats on rocky land in the Ozark region. The oats give some pasture the first year, while the orchard grass comes on the second year.

The spring conditions in 1906 on this field were not entirely satisfactory for securing a perfect stand and many weeds came in during this season. The grasses were allowed to stand until the fall of 1907 when the following observations were made: orchard grass and red top were showing best, providing a good deal of pasture; the timothy was rather scattering, as was the meadow fescue. Among the clovers the white clover made a fine clean stand. The other grasses and clovers had only scattering stands. The mixture was good, the varieties most prominent being orchard grass, timothy, red top and alsike clover.

The conclusions which can be drawn from this experiment are, first, that such grasses as orchard grass, red top and timothy are best adapted to this prairie soil with bluegrass showing only a fair adaptation; second, that alsike and white clover are best among the clovers and, third, that lime showed exceptional results on this soil, with fair returns being secured from bone meal and dried blood.

Experiment with A. J. McDowell, Fordland, Webster County

The experiment at Fordland was put out on a piece of badly worn ridge land on the Springfield group of soils. The following grasses and clovers were sown: bluegrass, timothy, red top, orchard grass, tall meadow oat grass, smooth brome grass, meadow fescue, sheep's fescue, red, mammoth, alsike and white clovers and alfalfa, together with the following mixtures: mixture No. 1, consisting of all the grasses and clovers; mixture No. 2, consisting of timothy, red top, tall meadow oat grass, sheep's fescue, red, alsike and white clovers; mixture No. 3, consisting of red top, sheep's fescue, bluegrass, red and alsike clover.

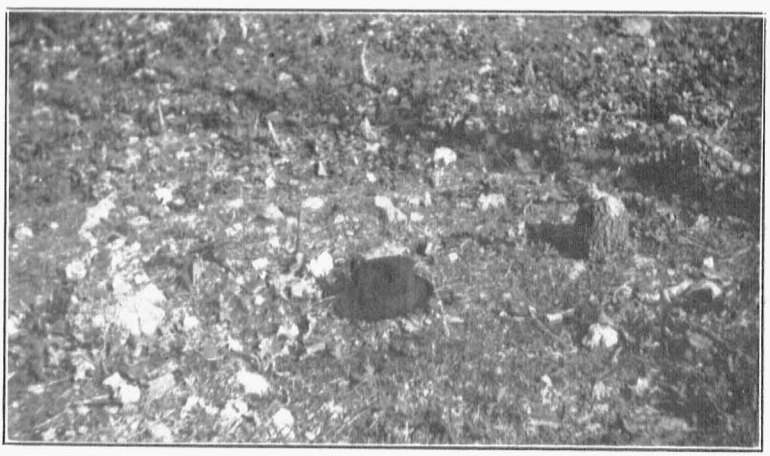
The grass plots were approximately one-tenth of an acre in size and cross-wise of these the soil was treated with manure, bonemeal, dried blood and lime as separate strips, while one strip was left untreated. The seeds were sown in the spring of 1907, but they failed to make a satisfactory stand. As a matter of fact, everything failed except on the manured strip where red top, orchard grass and mammoth clover made a good stand, while tall meadow oat grass and red clover made a fair stand. In the mixture of all, the tall meadow oat grass, timothy and orchard grass predominated. The other mixtures which did not contain orchard grass were not so good.

Owing to the unsatisfactory stand, the plots were replowed

and reseeded in the fall of 1908 and again rather a poor stand was secured, but the following observations were made in June, 1909: bluegrass made a scattering stand on the plots treated with bone-meal and manure, as did timothy and red top. Orchard grass made rather a poor stand over all the soil treatments. Tall meadow oat grass made a scattering stand on the manured land alone. In mixture No. 2, red top, timothy and tall meadow oat grass predominated and in mixture No. 3, red top and bluegrass. These results are, of course, not conclusive, although practically the same grasses prevailed each time. Manure and bone meal were both of benefit in securing a stand.

Experiment with A. D. King, Garrison, Christian County

The experiment at Garrison was put out on typical upland soil representing the Springfield group. No fertilizers or other soil treatment was given except that the ground was plowed and harrowed to a seedbed and the seeds sown in the spring of 1911. The following grasses and clover were used: orchard grass, timothy, red top, English rye grass, Canada bluegrass, Kentucky bluegrass, tall meadow oat grass, red clover, alsike clover and white clover, together with the following mixtures: mixture No. 1, orchard grass, timothy and red clover; mixture No. 2, orchard grass, timothy, Canada bluegrass, red and alsike clover; mixture No. 3, orchard



A typical condition in newly cleared, rocky land, showing little growth on the soil in the spring. This land has been sown to orchard grass. Goats or hand cutting must be used to keep down the sprouts.

grass, timothy, Kentucky bluegrass, Canada bluegrass, red, alsike and white clover; mixture No. 4 was a mixture of all.

The grasses on the whole came well and went through the dry season of 1911 in pretty good condition. The following observations made in October, 1912, show the condition after the second season: orchard grass had 90 per cent of a stand and was of very good growth; timothy had 85 per cent of a stand and was good; red top had 75 per cent of a stand and was good; the English rye grass had 70 per cent of a stand, a medium growth and seemed very well adapted to the soil; the Canada bluegrass had a stand of 70 per cent and the Kentucky bluegrass 80 per cent, while each showed a medium growth and a fair adaptation to the soil; red clover had 90 per cent of a stand and was very good; alsike clover had 80 per cent of a stand and was good; white clover had 85 per cent of a stand and was medium good; all the mixtures gave excellent results but there was seemingly not much choice between them.

From the results of the experiment, it will be seen that the grasses which seem best adapted to these conditions are orchard grass, timothy, red top and English rye grass, the Canada and Kentucky bluegrass showing a fair adaptation. Among the clovers, all did well.

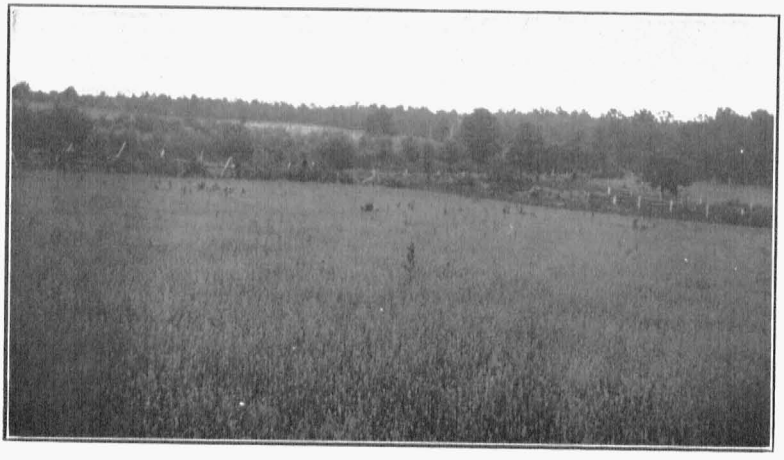
Experiment with J. R. Linebarger, Purdy, Barry County

The experiment at Purdy was put out on rocky upland belonging to the Springfield group of soils. The land had just been cleared of the brush and was plowed and harrowed in preparing it for the grasses. The grasses were sown early in the spring of 1911, harrowing the seeds in lightly with a brush harrow. The grasses were put out in one-tenth acre plots the same grasses, clovers and mixtures being tested as in the experiment last reported. The grasses stood the dry summer of 1911 fairly well and the following observations made in October of 1912 shows the conditions at the end of the second season: orchard grass had an excellent stand, showing very good; timothy had a medium stand and was fair in growth; red top had an excellent stand and showed a good growth; English rye grass had about 70 per cent of a stand and had only a fair growth; the Canada bluegrass had an excellent stand and made a good growth; the Kentucky bluegrass had only a medium stand and did not seem to be so well adapted as the Canada bluegrass; the red clover had a medium stand and a fair growth and was somewhat affected by the dry weather; the alsike

clover had a poor stand and a poor growth, not looking very well. Of the mixtures, No. 2 seemed to be the best, having an excellent stand and a good growth; No. 1 had a good stand and, while it had a good growth, it was not so good as No. 2; No. 4 was next best, with a good stand, while No. 3 had only about 75 per cent of a stand and did not seem to be quite so good as the others. It can be seen that according to this experiment, the individual grasses and clovers which seem best adapted are orchard grass, red top and Canada bluegrass among the grasses, and red clover among the clovers, while timothy and Kentucky bluegrass as well as the alsike and white clover were fair.

Experiment with John Cologna, Marshfield, Webster County

The experiment at Marshfield was put out in the spring of 1910 on some old, cleared land of the Springfield group of soils which had been in pasture. The plots were approximately one-tenth acre in size and the following grasses and clover were sown: timothy, red top, Kentucky blugrass, Canada bluegrass, orchard grass, perennial rye grass, tall meadow oat grass, smooth brome grass, alsike clover, mammoth and white clover, together with the following mixtures: mixture No. 1, orchard grass, timothy and red clover; mixture No. 2, orchard grass, Canada bluegrass, red clover



An abandoned field grown up to bracted plaintain, sometimes incorrectly called buckhorn in this region. Japan clover will come in such fields among the plantain where the clover is introduced but a very much more satisfactory pasture could be obtained by seeding to orchard grass and clover. Under such treatment, land of this character would yield good pasturage.

and alsike clover; mixture No. 3, orchard grass, Kentucky bluegrass, Canada bluegrass, timothy, red, alsike and white clovers; mixture No. 4, a mixture of all.

The spring and summer of 1910 were favorable, but the season of 1911 being exceedingly dry, the only grasses which stood this dry weather satisfactorily were orchard grass, Kentucky bluegrass and Canada bluegrass. None of the other varieties of grass did much good and the clovers were also poor. While this experiment is not at all conclusive, it indicates very strongly that such grasses as orchard grass, Kentucky and Canada bluegrass are best adapted to that region.

Experiment with R. D. Calkins, Knobview, Phelps County

The experiment at Knobview was put out on the Union group of soils on an old cleared field. The grasses were sown in the spring of 1910 and the same grasses, clovers and mixtures were used as in the experiment at Marshfield. The report on this experiment for 1911 showed that a good stand of all the mixtures, as well as red and white clovers, was secured, and a fair stand of timothy, red top, orchard grass and tall meadow oat grass. Mr. Calkins reports that, in his experience, red clover, orchard grass and red top are the only varieties that will catch well in the woods, while bluegrass will come in where a piece of ground has been pastured for sometime and also in places where stock stand a great part of the time. This experiment, while not conclusive, indicates the adaptability of orchard grass, red top and timothy and a fair adaptation of tall meadow oat grass, bluegrass, red clover and white clover. The fact that all the mixtures did well would indicate that a mixture of orchard grass, red top and bluegrass or timothy, together with red and white clover would make a satisfactory pasture.

SUMMARY OF THE EXPERIMENTAL RESULTS

An examination of the reports of these experiments shows that there is little distinction to be made in the adaption of any of the grasses tested to the different groups of soils, with the possible exception of the adaptation of orchard grass to the Springfield group. On the other hand, there are a few of the grasses which show almost a universal adaptation. Of these, orchard grass, red top, Kentucky bluegrass and timothy are the most important. The

most striking thing that has been shown, however, is the special adaptation of orchard grass to this region. This grass seems to be especially hardy and well adapted to practically the entire Ozark country and it is by far the most productive of all grasses on the drier lands. Red top has also shown itself very hardy on most of the soils, although it is not a very satisfactory grass when used alone. Bluegrass has been shown to be fairly well adapted practically everywhere, except on the drier lands where orchard grass is much to be preferred. Of the clovers, the red, alsike and white have proven quite generally adapted to all but the driest lands, where their place will undoubtedly be taken by Japan clover.

The results of the application of manure and fertilizers show a universal benefit from manure and almost a universal benefit from bone meal, while the dried blood does not seem to be a paying application; lime gave a return of consequence in only one instance.

FIELD INVESTIGATIONS

The field investigation which was planned as an adjunct to the plot experiments with grasses and clovers in the Ozark region was conducted by A. W. Orr who spent the summer of 1912 in that section studying the practices of the best farmers in the matter of handling pastures and meadows. The investigation included

A thick stand of Japan clover growing among buckhorn. This land should be broken and sown to orchard grass and clovers.

twenty-five counties of the Ozark region and the report which is here presented represents the experiences of scores of farmers who were personally interviewed, often in connection with a visit to their farms. The matters which were given particular attention in this field investigation were the following: first, varieties of grasses and clovers best adapted for pasture and hay in the various sections; second, methods of seeding and handling grasses for pasture and for hay; third, means of controlling the undergrowth and timber; fourth, practical methods of establishing profitable pastures on the rocky lands now covered with cut-over timber and undergrowth.

It is obviously impractical to give a report of the experience of each farmer individually, so that the data here presented is a summary of the material collected, arranged in a form which is designed to bring out the more important facts determined. It should be said that this investigation was carried on by means of a horse and buggy and the route followed had no particular relation to railroads. The conditions observed should, therefore, be representative of the Ozark region.

In summarizing the results secured, they can be divided broadly into two groups: first, facts regarding the control of the undergrowth and timber which can be designated as the undergrowth problem and second, facts regarding the grass adaptations and methods of handling pasture and meadow grasses in the various sections which can be designated as the pasture problem proper. The first of these problems is really the most difficult one of the two. The plot experiments which have been carried out and the field observations which have been made, show very definitely, that with the exception of comparatively small areas, grasses and clovers can be satisfactorily grown for pasture in all parts of the Ozark region where the undergrowth can be controlled. On the areas where profitable pastures cannot be grown, it will undoubtedly be more profitable to leave this land in timber. It is, of course, understood that some timber will be left on practically every farm, either for lumber or for supplying a shaded pasture, but there are sections where the growing of timber will undoubtedly be more remunerative than the growing of pasture grasses.

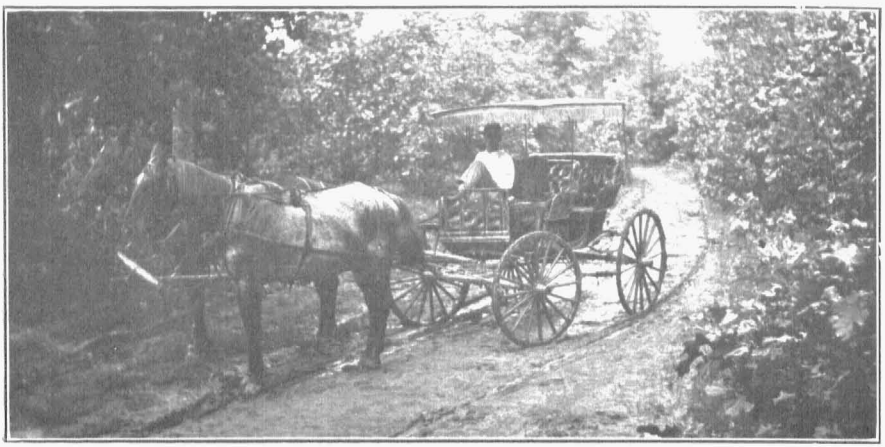
As a proof that the Ozark soils will practically all produce grass, the fact can be cited that within the memory of the older inhabitants of this region the larger part of this country was covered with a heavy growth of blue stem grass. This was burned off

each fall or winter, which effectually kept the undergrowth in check, although the burning did not affect the larger timber. With the coming of the lumber and mining camps, however, and with the removal of the larger timber, the country became more thickly settled and the burning over of the land was stopped. A dense undergrowth of brush then sprang up and much of the land, which was at one time excellent range, has now become a thicket of underbrush through which it is almost impossible to ride a horse. The greatest problem, therefore, is to get rid of this undergrowth and let in sufficient sunlight so that grasses will grow.

Unfortunately, very little has been done by the farmers of this section toward the establishing of permanent pastures. The difficulty of controlling the brush together with the fact that there is so little of the land under fence makes it much easier for men to allow their stock to run in the open range and get what they can. The development of permanent pastures free of brush is therefore dependent, first, upon the establishment of stock laws, and second, upon the improvement of agricultural methods among the farmers. So long as there is abundant free range, even though it be very poor, there is little incentive for farmers to put the necessary expense and care into the cleaning up of brush land and the establishing of permanent pastures. That it can be done and done profitably, has been shown by the experiments which are here reported and by the experience of progressive farmers in practically all parts of this region.

THE UNDERGROWTH PROBLEM

In discussing the undergrowth problem with reference to pastures, it must, of course, be understood that there are all sizes of timber and all stages of brush development, depending upon the region and upon the manner in which the land has been handled. There is, of course, some large timber left, although the greater share of saw timber has been used. The bulk of the country is, therefore, what is termed cut-over land, with trees in most cases too small for saw timber and with much underbrush. As has been mentioned, it will be wise, on most farms having timber land, to leave a part of the land with sufficient large timber to give shaded pasture and to supply wood, as well as some lumber, as needed. Where the timber is too small to be of value and where it is desired to remove all of it, there are various ways in which this is



A typical road through the cut-over timber, country grown up to undergrowth. This undergrowth must be removed before grasses can be grown satisfactorily.

done. One method is to deaden practically all the larger trees and cut the smaller ones, together with the largest of the brush, and pile in windrows until dry enough to burn. A few trees should usually be left in any pasture although some men prefer to cut them all. After the trees have been deadened and the brush piled, the ground is burned over during the winter and the land sown to grass and clover seed in the spring, the sprouts being removed during the next two years with goats.

It has been found, too, that where the undergrowth is not too thick, the grass is best sown in the spring preceding the deadening of the timber. In this case the shade of the timber helps to protect the young grass somewhat, but as it is deadened so as to allow the sun free access during the next year, the grass comes on well and, if goats are used or if the sprouts are handcut in May and August, a very satisfactory pasture may be secured. Cattle, if used in sufficient numbers, will keep the sprouts down fairly well. The accompanying photographs show the difference in the character of the weeds and undergrowth where the grasses were seeded before and after deadening.

Another method of getting rid of the timber is to cut it in early summer, leaving the stumps two or three feet high and allowing them to rot out. In this case the tops may be left where they fall and the whole burned over during the fall or winter. Sometimes the whole is allowed to lie a year so that the sprouts come

up from the stumps, then it is burned over. These plans are not recommended because of the danger of the fire getting beyond control, but they are effective in cleaning the land so that grass seed can be sown and the sprouts thereafter kept down by cattle, sheep, goats or by hand. Another plan is to cut all trees and brush low, pile and burn, seeding to grasses and clovers in the fall or spring. There is no plan of universal adaptability but one of the plans, where the brush is burned either in piles or windows, among the deadened larger timber or where the whole is cut and piled, is usually preferable. It goes without saying that all marketable trees should be saved, where such exist, although this discussion refers particularly to cut-over land where there is little or no timber of value.

SPROUT KILLING

Assuming that the largest undergrowth and the bulk of the timber has been removed, the next matter is that of freeing the land of the sprouts which follow this clearing. If they are not eradicated they will again cover the whole area with a brush thicket. Naturally, there are various means of eradication and no single method is of universal adaptation. Before taking up methods in detail, however, a word should be said regarding the principles upon which sprout killing is based. Tree growth in early spring, that is the budding and putting out of leaves, is dependent upon a store of material within the plant. Such material is stored during

Land cultivated to corn to kill sprouts. It is also necessary to do some hand cutting in addition, if the sprouts are eradicated.

the preceding season and the leaf is the most important organ concerned in the elaboration of food materials. With fully developed leaves, a tree or shrub continues to elaborate its store of organic materials within the plant, some of which are used in growth the immediate year and some of which are stored to start growth the following year. A young tree which is prevented from maintaining leaves for any considerable length of time during the growing season will, naturally, store very little organic material and the growth the following season will be correspondingly weak. Consequently, if the leaves or sprouts are continually removed as they are formed, as can be done by cutting or by means of such animals as goats, they fail to store food and will either be entirely prevented from throwing out new growth the following season or they will be greatly weakened. When young sprouts put up from stumps or roots and produce leaves and then are removed in May or June, they will again put out, using such reserve food as may be left in the stump or root. If these are again cut off in August, they will usually not appear again that season, and the following spring such shoots as do appear will be much weakened on account of the small amount of reserve food left in the stump or roots. The problem, therefore, is to find the means by which the storage of this food material in the roots or stumps, from which sprouts are growing, can be most economically prevented.

REMOVING UNDERBRUSH BY HAND

The most common method of removing underbrush is by means of an ax or grubbing hoe. There is no more efficient method if it is followed up consistently so as to prevent the growing of sprouts for any considerable time during the season. The difficulties lie in the expense of the operation, and in the trouble in securing men who will do the work properly even when paid for it. The work should be done, too, during those seasons of the year when farmers are busy with other things or when the weather is very hot, so that sprout cutting by hand is really a very difficult matter to handle. One of the great difficulties is that men cut sprouts at the season of the year when it is easiest or when they have time and not at the time when it will do the most good. It also happens that men often cut sprouts more for the purpose of getting a crop on the land than for the purpose of permanently ridding the land of them. Of course, where land can be cultivated, one of the very

Removing sprouts by hand. Goats usually do this cheaper.

best ways is to remove the sprouts and underbrush sufficiently by hand to allow the land to be put in corn, relying upon the cultivation of the corn to clean the land. It usually takes two or three years of cultivation of corn, with additional sprout cutting around the stumps, to clean land absolutely. It is a very satisfactory way, however, on land that is good enough and sufficiently free of stones to make corn growing profitable. Naturally on the more rolling land, not suited to tillage, other means of getting rid of sprouts must be found.

If a man wishes to remove sprouts with the least labor on land that cannot be cultivated, or if he wishes to remove them quickly even on cultivated land, the best time to do the work is in June and again in August. The first cutting will get the spring growth and the second cutting will get those, which put out later, in the attempt to store material for the coming year. The difficulties in the plan have already been suggested but if it can possibly be arranged to do the work at these times, it will be found by all odds the most economical procedure where hand cleaning is practiced. Some men have had marked success in dealing with sprouts by cutting them with the mowing machine two or three times during the summer. Where land has been once thoroughly cleaned by the ax so that a mower will run, this is a good plan, although it is necessarily limited to areas where a mower can be handled.

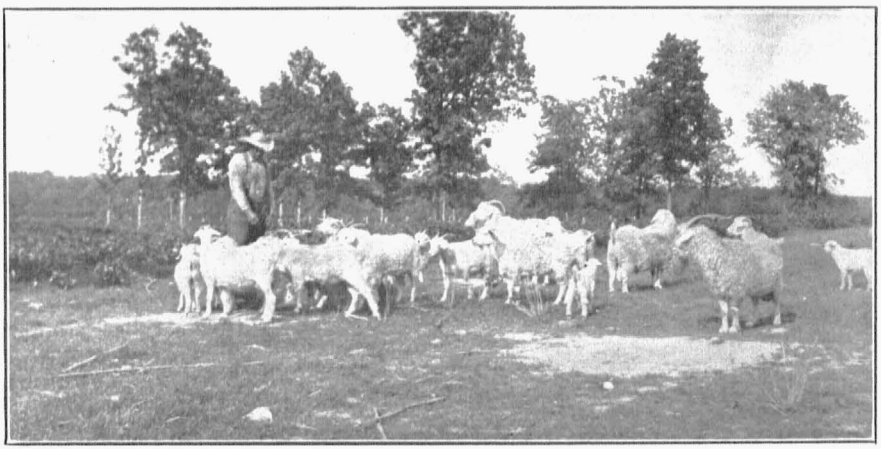
GOATS AS SPROUT KILLERS

There is probably no better way to cope with the sprout situa-

tion than through the use of goats or sheep. According to general experience, however, the goats seem to be preferred, although conditions must determine in this matter. Where goats are used, the Angora is most commonly employed and they are to be preferred where they can be secured at a reasonable cost, as they have practically all the points of utility of the common goat, together with additional advantages. It must not be inferred from this that Angora goats can be used as brush killers and still make large returns from the fleeces, as this is not true. Experience indicates that, as a rule, there is not a great deal of money to be made from the goats themselves when they are used for this purpose, although some men have reported good net returns.

It requires from two to three seasons to entirely rid land of sprouts by the use of goats. Although much depends upon the number of goats kept on the ground and upon the character of the brush, two seasons is the ordinary period necessary. If much of the timber growth has reached considerable size, the usual plan is to cut the trees and allow the goats to work on the young sprouts coming from the stumps.

Angoras do best on dry, rocky land; wet and marshy soils are not favorable to success with them. It is also essential that they have pure drinking water. Naturally, this is afforded in most rocky regions. This does not mean that they cannot be handled successfully on grass but that for best conditions some brush land

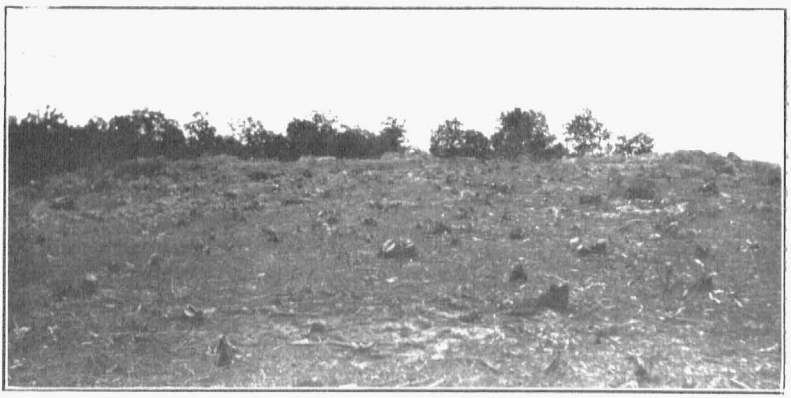


Goats used for killing sprouts in the Ozark region. The landscape is typical of that region.

is desirable. On the other hand, many farmers believe that, in order for goats to work effectively on sprouts, all grass or other vegetation must be lacking. The experience of farmers who have used them indicates that this is not the case. A good example of this is seen in the accompanying cut made from a field on the farm of a man at Bismarck. This field was cleared of timber, the brush burned and a mixture of grasses sown. The goats were allowed the run of this pasture and, while the sprouts were killed out in two seasons, they bothered the grass but very little, so that within two years this land, with a heavy growth of brush and timber, was transformed into a good pasture. It is true, that some farmers were found who had discarded goats, because they seemed to prefer to eat the grass and leave the sprouts. According to men who have had much experience, however, this is usually due to the fact that the goats are suffering from sore mouths. This cause often prohibits them from attacking the brush as they should. It is, therefore, recommended that in purchasing goats, every mouth should be examined. This will necessarily require that the purchaser go himself and select the goats where they are bought on the general market at St. Louis or Kansas City. Where the goats are bought in the neighborhood, this examination can be readily made. It is also desirable to select only young goats as they have better mouths and seem less susceptible to disease. Missouri grown Angoras are to be preferred where they can be gotten, although this is not a very vital matter. Most goats on the Kansas City and St. Louis markets come from Texas and New Mexico and are fairly good for Missouri conditions. The heaviest runs on the market are usually in the spring when they are in fair condition weighing from 75 to 85 pounds and costing, as a rule, from $3.00 to $3.50 per hundred.

As to the number of goats to use per acre, there is a wide difference of opinion. As a matter of fact, this depends on various factors, such as the condition of the brush, the character of the land and the time in which it is desired to accomplish the work. The number, therefore, ranges from two to fourteen, but from three to five give very good service under ordinary conditions. A less number is usually used the second year as the sprouts are less abundant.

While all goats are rather hardy animals, they must, nevertheless, be given attention if they are to be used successfully in clearing land of brush. The principal things to be considered are shelter, feed, water and proper attention at kidding time. The An-



A field near Bismarck cleared by hand and sown to grass in the spring, with a mixture of orchard grass, bluegrass, red top and white clover. It was pastured by goats after seeding. The sprouts have been kept down and a good catch of grass secured. This shows the condition during the first summer.

goras are not quite so easily handled as the common goat, although there is no great difference in the method of handling the two sorts where good results are to be secured.

The shelter need not be arranged with much attention to temperature but they must have a place to keep dry. Where running in rocky regions without shelter, it is a well known fact that they make every use of the shelter afforded by caves and ledges of rock during rainy weather. This is particularly true of the Angoras which are natives of a rather dry region in Asia Minor and are, therefore, unaccustomed to much wet weather. Their heavy fleeces when once wet, dry out slowly. If kept dry, they are like sheep in being able to withstand great extremes of temperature. The shelter should be large enough to avoid crowding, and the bed must be dry and reasonably clean.

As already stated, goats prefer coarse feed. They will live on weeds and brush, together with wild grasses, during the summer, and during the winter they can get along fairly well on the buds, tender twigs and bark of young trees if they have plenty of range, thus requiring little feed except during stormy weather or snows. This, however, is rarely, if ever, to be recommended. They should be provided with extra feed during the winter months. Hay, fodder and straw are the common feeds used. They seem to tire of hay, even alfalfa, if fed alone, and as they are fond of straw,

this can well form a part of their ration. A little grain should be fed, especially toward kidding time.

In fencing for goats, a woven wire or barbed wire is best as they will climb a rail fence unless perfectly straight up and down. The common kind recommended is the 26 inch woven wire with three barbed wires above, and posts one rod apart. Care should be taken to avoid large rock or stumps near the fence as they will often jump the fence where these offer an opportunity. The woven wire fence should have a small mesh to prevent the goats getting their heads through, as they are very apt to hang by their horns. In case of the barbed wire, if the wires are wide apart, there is little danger.

A field adjoining that shown on the preceding page, handled in exactly the same way except that the clearing and seeding was done one year earlier. The picture shows very good pasture.

Those who contemplate buying large numbers of goats for clearing land should consult the literature on Angora goat raising. It is not wise to speculate on large returns from the fleeces or the kids, as is often done in articles dealing with these animals. Experience teaches that there is little to be made from the fleeces under the climatic conditions existing in Missouri, where they are expected to kill sprouts as their main purpose. The fleeces average only from two to five pounds, as a rule, and as they begin shedding in April shearing must be done during that month, when there is still considerable cold, damp weather. The result is that some are usually lost and, since the fleeces from goats running in the brush are not worth much more than sheep's wool, the shearing is not a

very paying proposition. It is the exceptional man, who makes any considerable return from the goats, while clearing sprouts. It must be remembered that goats do their best service as sprout killers while less than four years old, and that mouth troubles usually develop with age.

A very common expression among men who have used goats is that bluegrass follows them. The reason for this belief doubtless is that the removing of the brush lets in the sun, while the tramping of the goats compacts the soil and doubtless tramps in some grass seed that would not germinate otherwise. It is probably due in part to the fact that the manure from the goats acts as a concentrated fertilizer to stimulate the growth of the grass here and there and this grass, under the trampling, gradually spreads. Many men say that the use of goats is the only essential to getting good pastures on practically any Ozark land. While this statement is doubtless too sweeping, especially on the rockier and drier lands, it indicates the importance of the goat in that region, particularly where used with the artificial seeding of the proper grasses.

While the preceding discussion has referred almost entirely to the Angora goat, it will apply in most particulars to the common goat as well. In this investigation, some farmers were found who preferred a cross between the common goat and the Angora, while others favored the common goat. As a matter of fact, the common goat or even a cross is undoubtedly easier to handle, and somewhat more hardy than the Angora and for these reasons may be preferred by some men; but the Angoras will bring in a little more money than the common goat, although, as has been said, they cannot be counted on as money makers outside of the return secured in the killing of the sprouts.

SHEEP AS SPROUT KILLERS

The use of sheep as sprout killers has been quite widely practiced in the Ozark region, although most men who have had experience with both goats and sheep think that the former are preferable. Much, of course, depends on the character of the land, the timber, the brush, the kind of sheep and the man who is handling them, as to their value for this purpose. Some men prefer them. Sheep require much more grass and other feed than goats, but will do very good work in cleaning up brush where properly handled. They are more efficient in destroying weeds than are the goats.

A field in Oregon County which has been cleared by hand and the sprouts cut with a grubbing hoe. The land is quite rocky but a good pasture of orchard grass, red top, timothy and red clover has been secured. This pasture is two years old.

They require more care and are, of course, much more in danger of dogs than are goats, but since the lambs are worth more on the market and since the mutton is better than the meat of goats, they can often be handled with some profit while cleaning up weeds and brush. The time required to rid the land of sprouts is longer with sheep than with goats and this allowance must be made. For men who are familiar with the handling of sheep and who like them, they may prove as satisfactory as the goats, but this statement would not hold for the average man.

The cost of freeing the land of timber and undergrowth sufficiently to allow grasses to grow, will depend upon the amount of growth and the methods employed. As a rule, this cost will vary from $3.00 to $8.00 per acre. The exact cost will depend upon the thickness and size of the timber, the method employed, the time allowed, and the cost of labor.

PASTURE GRASSES AND PASTURE MANAGEMENT

After the problem of controlling the undergrowth has been solved on those lands where pasture is desired, the next matters to be considered are those of grass adaptations and pasture management. The results of the grass experiments have already been discussed and there remains the summary of the opinions of farmers

regarding this matter. The table which follows summarizes a total of 91 written reports or interviews. Many more than this number of farmers were interviewed and many of these reports represent the consensus of opinion of a large group of farmers.

Tabular Summary of
Reports of Farmers Regarding Grass and Clover Adaptations

No. of men preferring bluegrass alone for pasture	14
No. of men preferring bluegrass in mixture for pasture	44
No. of men preferring orchard grass alone for pasture	14
No. of men preferring orchard grass in mixture for pasture	22
No. of men preferring red top in mixture for pasture	18
No. of men preferring white clover in mixture for pasture	28
No. of men preferring timothy and clover in mixture for pasture	2
No. of men preferring timothy for meadow	59
No. of men preferring timothy and clover for meadow	15
No. of men reporting Japan clover as a benefit	55
No. of men reporting Japan clover as a pest	11
Total number of reports	91

It will be seen from this summary that the general opinion among farmers of this region is that bluegrass in a mixture is one of the best pasture grasses, while red top and white clover are also looked upon with favor. Timothy, for a hay grass, is very generally recommended for the better lands.

DESCRIPTION OF GRASSES

The plot experiments reported in this bulletin, together with the field investigations of the practice followed by the most successful men, have indicated quite clearly the grasses and clovers which are best adapted to this region. It was thought, when these investigations were undertaken, that wide differences would probably be found between the grasses adapted to the different soil areas, and, while some special adaptations were observed both in the plot work and in the field investigations, these were not of great importance, and at least until the studies have been carried out in much greater detail, no special adaptations for the different sections can be given. As a matter of fact, so far as pasture grasses are concerned, the most striking differences in adaptation are between the deep, moist soils that are free of stone, and the rocky

Bluegrass sod on the grounds of the Missouri Tuberculosis Sanitorium at Mount Vernon. This land has been cleared to about one-fourth of a stand of timber cut to the ground and the use of a mower two or three times a year for two seasons effectually eradicated the sprouts. The bluegrass was sown to secure this stand and the land now gives fair pasture.

or dry, gravelly soils, regardless of their location or origin. The former will produce practically all of the common grasses without difficulty as it is merely a matter of using grasses which are gen-

A virgin pine forest in Oregon County. Large trees and good range of wild grasses. After clearing, this land grows up to undergrowth thus largely preventing the growth of grasses. Land immediately adjoining this had a typical growth of oak underbrush.

erally known in Missouri as good pasture grasses, while on the latter class of soils, the hardier grasses, such as orchard grass and red top, are better adapted. The discussion of varieties which follows will therefore have to do with the general adaptability of the grasses to the types of land mentioned above, rather than to particular soil areas.

Kentucky bluegrass. This is the most common pasture grass of South Missouri and it is found generally distributed wherever the timber and brush have been removed. It cannot be said, however, that it is as well adapted to this region as it is to many of the deeper, more moist soils of North Missouri. The bulk of the upland soils in the Ozark region proper are too dry for its best development. It finds its highest adaptations in the better soils which are not too gravelly and which hold water well. Bluegrass has the universal fault of passing into a dormant period during the heat of summer, at which time it gives little pasture, and this period is lengthened and the condition intensified in the dry lands of the Ozark region. It comes early in the spring, however, and freshens up again in the fall when the cooler weather and fall rains come. The seeding of bluegrass in this region should be more widely practiced, especially in connection with other grasses and clovers, using clean high-grade seed for the purpose. Bluegrass seed weighs from 10 to 25 pounds per bushel, but seed weighing 15 to 20 pounds is good, providing its germination is not too low. Little bluegrass seed germinates over 70 per cent, owing to the difficulties which usually accompany the curing of the seed in the field. Seed germinating from 50 to 70 per cent would be considered good.

Canada bluegrass. This is a type of the bluegrass sometimes called "Virginia bluegrass" in Missouri. It is also sometimes called "wire grass," as its stems are shorter and tougher than those of Kentucky bluegrass. It is distinguished from Kentucky bluegrass by its flattened stem, its somewhat darker color and its somewhat stiffer less luxuriant growth of leaves. It is a hardy grass, being much better adapted to dry and thin lands than the Kentucky bluegrass, but its smaller productiveness and tougher, more wiry character have prejudiced farmers against it, so that while it is adapted to the Ozark region, there are other grasses that seem more desirable.

Meadow fescue. This is often spoken of as English bluegrass, and is mentioned here for that reason and not because it has any particular adaptability to the bulk of the Ozark region. It seems

to have a special adaptation to some of the border Ozark counties of the western part of South Missouri, particularly in St. Clair and Henry Counties where it is being extensively grown, but it does not seem to be as well adapted for the pasture grass in the Ozark region proper as some of the other grasses.

Orchard grass. Of all the cultivated grasses of the Ozark region, orchard grass seems best adapted on the dry, gravelly lands, preferably mixed with bluegrass, red top and clover, but doing very well alone. It is hardy, comes early in the spring, stands better than bluegrass throughout the hot summer months, holds well on the soil for long periods of time, and on the whole, seems to be better adapted to the average Ozark soil than is bluegrass. It grows in tufts and with age these become quite pro-

Land sown to a mixture of grasses and clovers in the spring and the timber deadened the following summer. The shade of the timber kept down the growth of weeds until the grasses became set so that a cleaner pasture was secured.

nounced, so that it is not an ideal pasture grass in appearance. It is also tougher and coarser than bluegrass, but its hardiness on these Ozark soils makes it a very valuable pasture grass. Orchard grass requires a couple of years to become well established, which is an added argument for mixing it with other things, particularly clovers, to occupy the land until it gets set. It is easily and cheaply seeded on new land after the brush and leaves are burned. It may be sown in the spring at the rate of 8 to 10 pounds of clean seed,

together with 4 or 5 pounds of clover per acre and usually with some bluegrass and red top. The grasses and clovers had best be sown separately, on account of the different weights of the seeds, the grasses being most readily seeded by hand. This seeding is best followed by a drag harrow, if it is possible to get one through the stumps; or, goats, sheep or cattle may tramp the seed in.

On the better lands of the Ozark region, orchard grass may be sown alone and cut for a seed crop. This is particularly true of certain of the border Ozark counties in Southwest Missouri. When handled for seed the stems, which are long and extend above the tuft of heavy foliage at the ground, can be cut with a binder, bound and threshed, while the remainder of the crop can be cut for hay or pastured off. This grass cannot be too strongly recommended for the Ozark region as a pasture grass alone, or in a mixture, on the dry gravelly lands, and as a hay, seed or pasture crop on the better lands, particularly in the western part of the territory.

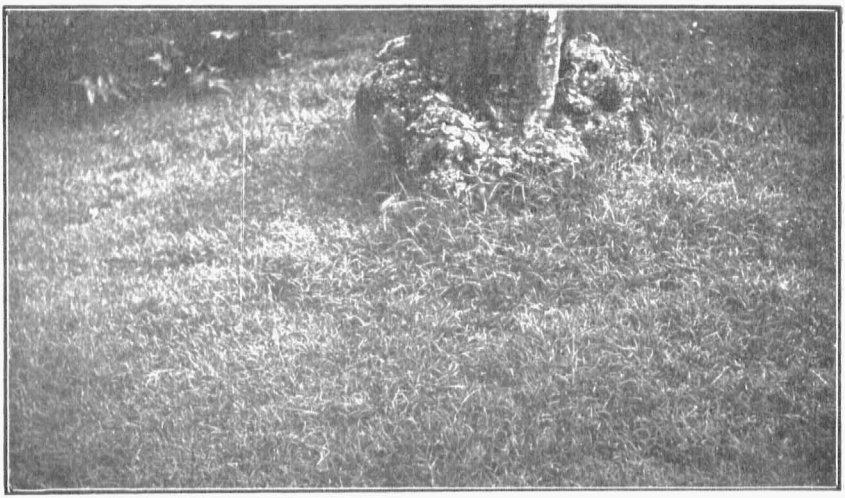
Red top. This is a grass that is rather widely spread and very well adapted to Ozark soils. It is used both for pasture and for hay. It is the grass next to orchard grass that seems hardiest as a pasture on the dry, gravelly or rocky lands, according to the plot experiments and field studies. It is not so good as bluegrass or

Land adjoining that shown in picture on preceding page where the timber was deadened in the summer, the grasses being sown the following spring. Note the growth of weeds as compared with the land shown in the preceding picture.

orchard grass for the average lands and it is less desirable on the dry, gravelly lands than orchard grass when sown alone. As a mixture on all gravelly and thin lands, however, particularly with orchard grass and clovers, as well as with bluegrass on all the medium to poor lands, except the very driest, it is valuable. Farmers in general in that region do not regard it as a good hay crop, but it is hardier than timothy on the poor lands.

Bermuda grass. This is a southern grass which spreads by surface and underground stems, making a dense mat which is valuable both for hay and pasture, in regions sufficiently warm for its growth. In southern states, it may be cut for hay two to four times during a season. In Missouri, it is not well adapted anywhere, but in the southern tier of counties it does fairly well, sometimes being grown with fair success as far north as Springfield. Thus far, its use in Missouri has been confined largely to lawns and lots and to levee embankments in the southern part of the state. It comes late in the spring, not starting much before the middle of May and dying down with the first frost. It will stand much hot weather and, if it is to come into use in the Ozark region, it will doubtless be on the drier lands of the southern counties where many other grasses tend to burn out. When once set, it is very difficult to eradicate so that it should probably be confined to lands which are to be left permanently in pasture. It is started most commonly by plowing in pieces of Bermuda grass sod in furrows at intervals of 3 to 4 feet and allowing it to spread. It may be started from seed, using 10 to 15 pounds per acre, but seed is somewhat expensive so that the other method is more common.

Timothy. This is the main hay grass of the Ozark region. It has a wide adaptation, both as regards soil types and climate. It is not as valuable a pasture grass as some of those already mentioned, but, in seasons when there is plenty of moisture distributed through the summer, it affords much good pasture. Timothy is usually sown in the fall, either with a nurse crop or alone. Many men prefer to sow it alone, because it can then be sown earlier and it makes a good crop of clean hay the first year. Where timothy is sown alone with a nurse crop, eight to ten pounds of seed is recommended and, where mixed with red clover, six to eight pounds of timothy and five to six pounds of clover. Where sown in the fall without a nurse crop, ten pounds of seed should be sown. Where timothy is used in a pasture mixture, from four to six pounds are sown, depending upon the grasses being used with it. Where the



Bermuda grass sod in Oregon County. This particular sod was in a yard where it had been planted for lawn purposes. It can be seen what a dense sod it makes. This grass has possibilities for the southernmost counties.

accompanying grasses are slow to cover the ground, as orchard grass or even bluegrass, and where the timothy with the clover must be depended upon largely for hay during the first season, the heavier seedings should be used.

Blue stem. In early days when the land was burned over annually and before the brush came, blue stem was the most important grass of the Ozark region. It is still found to a greater or less extent throughout the region, particularly in those few sections where the land is still burned over. When the brush is removed, it will sometimes come again but it is no longer sure. Men have tried to seed it on cleared and cultivated land, using seed gathered from the isolated patches in the neighborhood, as seed is not generally available on the market. Attempts to seed it have usually met with failure, so that no reliable information regarding the future possibilities of this grass in the Ozark region could be secured. The grass is very hardy and it makes a good pasture, although rather coarse, but it seems doubtful if it will ever again be brought into common use in this region.

Johnson grass. A word should be said regarding Johnson grass for this section. Johnson grass is a southern grass which spreads both by seed and by underground stems, and, in regions where it

is adapted, nothing can withstand it, when once established. It is almost impossible to eradicate it. It is not well adapted in Missouri north of the southern tier of counties, although it is sometimes found as far north as Perry County. It is not far different from blue stem in coarseness and is used in the south for a pasture with good success. The difficulty would be that where once set on rocky land, it could never be economically eradicated and there would be continual danger of its spreading into cultivated fields. One instance was observed in Ripley County where it had been introduced on rather rocky land and corn planted on this land had to be abandoned to it. Until further information is available, the Experiment Station would, therefore, caution men against its introduction in the southermost counties, because of the risk one runs in its becoming an uncontrollable pest. The other grasses which are adapted to this region make it unnecessary to risk the danger which the introduction of this grass might entail.

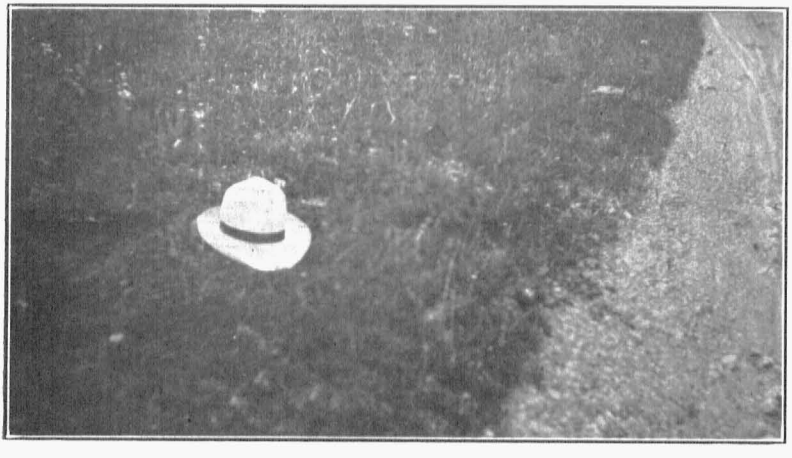
The Clovers. All the common clovers are adapted to the majority of Ozark lands, the red clover, mammoth clover and white clover being particularly well adapted. Besides the clovers, a large number of wild legumes grow abundantly in practically all parts of the territory, so that pastures need not suffer for want of leguminous plants of some kind. Clovers are rarely sown in the fall in this region, and except when sown in a pasture mixture, they are not usually sown without a nurse crop. For pasture purposes on rough lands, they are generally sown in the spring with grasses either on prepared or unprepared land, depending on conditions. On the rough land it is best to sow without stirring the soil, except to harrow once or twice after seeding, if possible.

Alfalfa. Alfalfa is grown in some sections of the Ozark region with success, but its use is limited largely to rich soils such as bottoms and the better valley lands. It can, however, be used in a pasture mixture with good results on lands that are of fair fertility, mixing three to four pounds with the other grasses and clovers.

Sweet clover. This is a large-growing, rather rank-smelling clover often called bee clover, is well adapted to practically all lands of the Ozark region and, where properly handled, may prove a valuable crop, particularly on thin lands. No conclusive experiments were conducted with it in this investigation and few men were found who had tried it, but its thrifty growth, where it is found here and there throughout the region, shows its adaptability. The Experiment Station has little first-hand experimental evi-

dence as to its value as a pasture or hay crop, but many men in other states are enthusiastic over it. Experiments are in progress at Columbia to learn its actual value, but the results are not yet sufficient to warrant recommendations. There is no doubt that it is sufficiently hardy and sufficiently luxuriant in growth to do well on most any of the dry gravelly Ozark lands.

Japan clover. The spread of Japan clover throughout a large part of the Ozark region has been looked upon with apprehension by some men, although the general experience with it has very largely removed this doubt as to its benefit. Only a very small per cent of the men interviewed expressed a dislike for it, the sentiment being overwhelmingly in its favor. The clover is a small growing species suited to a warm country so that it comes late



Japan clover growing on dry, gravelly land in the Ozark region. The road shown at the right is almost a natural macadam of flinty gravel. It will be seen that the Japan clover covers this gravelly land completely.

in the spring and is killed by the first frost. It is an annual, producing abundant seed and, when once established, it comes up thickly every year and gradually spreads. The fact that it comes so late, after the grasses have made a large share of their summer growth, prevents it from seriously interfering with the growth of other plants. It has the advantage of being in full vigor during the dry period of July and August when the grasses and most of the clovers are short. There can be little doubt that this clover is to be of advantage to the Ozark region. It will grow on the driest and poorest soils, and while under such conditions its growth is at

first very short, usually not over a couple of inches, it builds up the soil in nitrogen and organic matter, making it more fertile.

SUMMARY OF RECOMMENDATIONS REGARDING PASTURE MANAGEMENT IN THE OZARK REGION

The results of these investigations are sufficiently conclusive to warrant certain quite definite recommendations regarding pasture management in the Ozark region. The matter of securing profitable pastures depends, first, upon the permanent removal of the undergrowth, and second, upon proper methods of pasture management, including the proper selection of grasses and clovers, as well as methods of seeding and handling. Before undertaking the establishment of a pasture, however, one must decide as to whether the land is of such a nature that it can be more profitably handled in pasture than in timber. In deciding this matter, one must not only use judgment as to the adaptability of the land to pasture, but he must also determine the probable acre cost and decide whether or not his system of animal production will justify the development of tame grass pastures on the land in question. As to the adaptability of grasses to the soils of this region, the investigations indicate that there are few soils on which one or more of the tame grasses will not grow so as to make a fair pasture where properly handled, although the drier and more rocky the soil, the less pasturage can one expect.

REMOVING THE TIMBER AND UNDERGROWTH

In cases where the merchantable timber has been removed, an inexpensive method is to deaden the remaining trees during the summer and allow two or three years for them to rot down. If the undergrowth is not too thick, grass can be seeded in the spring. before deadening, to good advantage, using goats, sheep or cattle to keep down the sprouts and undergrowth for two or three seasons following. Where the undergrowth is heavy, it must be cut and burned before seeding, in which case the seeding can be done the following spring. A few trees should usually be left standing to give some shade to the animals, and care should be taken to burn the leaves before seeding, where the ground is covered with a heavy layer of them. Another plan, which is quicker but more expensive,

is to cut the timber either at a height of two and one-half feet from the ground or at the ground, pile the brush and burn, seeding the following spring. In this case, as in the other, goats, sheep or cattle should be used for two or three years, or hand cutting must be depended upon, to kill the sprouts.

Where the growth is mainly brush, the best plan is to cut and burn, seeding the following spring and using goats, sheep or cattle to eradicate the sprouts. In practically all cases, goats are to be preferred. The character of the timber and undergrowth, the time to be allowed in clearing the land, the money to be expended and the system of farming employed will determine the proper methods to follow in individual cases.

METHODS OF SEEDING DOWN PASTURES

According to the results of these investigations, recommendations regarding pasture management must be made under two distinct heads: first, methods for the better upland and valley soils of the region which are fairly well supplied with organic matter and hold water well; and second, methods for the more gravelly or rocky upland soils which are less well supplied with organic matter and tend to be dry and infertile. The first class of soils are much better adapted to the common grasses and clovers than are the latter, so that it is the latter class to which the greatest attention must be given in establishing a profitable pasture. It will be observed that the recommendations usually suggest mixtures of from three to six grasses and clovers rather than a single one. This is because a mixture is almost always more profitable for pasture than a single grass, particularly on these lands which are not exceptionally well suited to bluegrass. One of the greatest mistakes on any soil, which is not pre-eminently a bluegrass soil, is to depend upon a single grass, where more than one grass is adapted. The slight extra cost of the additional seeds will usually be returned many times in the better pasture secured from the mixture.

The importance of using good seeds of all kinds cannot be too strongly emphasized. Every farmer realizes what a great temptation there is to use seeds which are not of the best quality, because of their cheapness. As a matter of fact, the cheapest seeds one can buy are those of highest grade, although these are quoted at the highest prices. Cheap seeds are either low in vitality, and will thus fail to give a proper stand, or they contain certain weeds

which will greatly reduce the value of the pasture, sometimes ruining the pasture entirely. Many low grade seed samples are faulty, in both purity and vitality. It is highly important, therefore, that both grass and clover seeds be pure and of strong germinating quality. The recommendations that are here given are made on the assumption that the seeds used are of good quality and that the bluegrass seed, particularly, is free of chaff, weighing at least eighteen pounds per bushel. The mixtures recommended are not especially high in quantity; they are what would be termed fair seedings for lands of this sort. It is possible to secure fair pastures with somewhat less quantities than are here recommended, while in many cases it will be more economical to use even greater quantities than are suggested. These mixtures have been so calculated as to be considered within the means of most farmers and to be sufficient to give satisfactory results if seed of good quality is used.

Considering first the better soils of this region which are likely to be used for pasture purposes, mixtures such as the following are recommended, the amounts being given in pounds per acre:

(1) Kentucky bluegrass, 8 pounds; orchard grass or timothy, 6 pounds; red clover, 2 pounds; white clover, 2 pounds.

(2) Kentucky bluegrass, 8 pounds; timothy, 5 pounds; red top, 4 pounds; alsike clover, 2 pounds.

(3) Kentucky bluegrass, 8 pounds; orchard grass, 5 pounds; timothy, 5 pounds; red top, 3 pounds; red clover, 2 pounds; alsike and white clover, 1 pound each.

(4) Kentucky bluegrass, 8 pounds; timothy, 8 pounds; red clover, 5 pounds.

Orchard grass is not usually recommended to be used alone where bluegrass will do well, but it is a very satisfactory pasture grass, even on such lands, and the use of 8 pounds of orchard grass seed with 3 pounds of red clover and 2 pounds of alsike clover is good. The greatest difficulty is that it takes the orchard grass about two seasons to get to its prime so that 5 or 6 pounds of timothy seed or 8 or 10 pounds of perennial rye grass seed may be sown with this mixture to give pasturage the first year. The cost of these various mixtures runs from around $1.50 to $3.00 per acre at present prices of seed. It must be understood that, where grasses are seeded in the spring, little return is to be expected in pasturage the first season, in any case, unless the land is very good. The lands used for pasture in this region are few of them

rich enough to give much return the immediate season. The rye grass recommended in the last mixture given above is suggested because it will come on the first season, when spring sown, providing the land is of fair fertility, but the results of the experiments with this grass were only fairly satisfactory, so that at present it can not be generally recommended.

For the drier, more gravelly lands, mixtures such as the following are recommended in pounds per acre:

(1) Orchard grass, 8 pounds; Kentucky bluegrass, 5 pounds; red clover, 3 pounds;

(2) Orchard grass, 8 pounds; Kentucky bluegrass, 5 pounds; red top, 4 pounds; red clover, 2 pounds; white clover, 1 pound;

(3) Orchard grass, 8 pounds; Kentucky bluegrass, 5 pounds; timothy, 5 pounds; red top, 4 pounds; red, alsike and white clover, 1 pound each.

For the very driest lands at all suitable for pasture, a mixture of 10 pounds of orchard grass, 5 pounds red top and 4 pounds of red or mammoth clover is to be recommended, or a mixture of 10 pounds orchard grass and 5 pounds of red or mammoth clover for a cheaper application.

Spring seeding is almost invariably to be recommended, preferably without disturbing the ground other than to burn the leaves where they are heavy. If the land is clean enough to allow of it, a drag harrow of some kind should be run among the stumps after the seed is sown. The tramping of animals gives somewhat the same results in getting the seeds into the soil so that they will germinate. Where the land is clean enough, the seeding of 1½ to 2 bushels of oats per acre before harrowing is sometimes advisable as these will give some pasture the immediate season. On the better lands that are good enough to grow oats for grain, and where the land can be prepared, there is a temptation to let the oats ripen, but this is rarely advisable where establishing a pasture is the main object, unless they are sown very thin. Another method that is occasionally used in getting land seeded to grass in this region is to feed hay, preferably a mixture of timothy and red top, over the land which it is difficult to get into grass. The seed shattering from the hay is tramped in by the animals, and this, with the manure, is a great help in getting grass started. In such a case, some bluegrass and orchard grass seed with a little clover had best be broadcasted before feeding on the land, if hay of these grasses is not available.