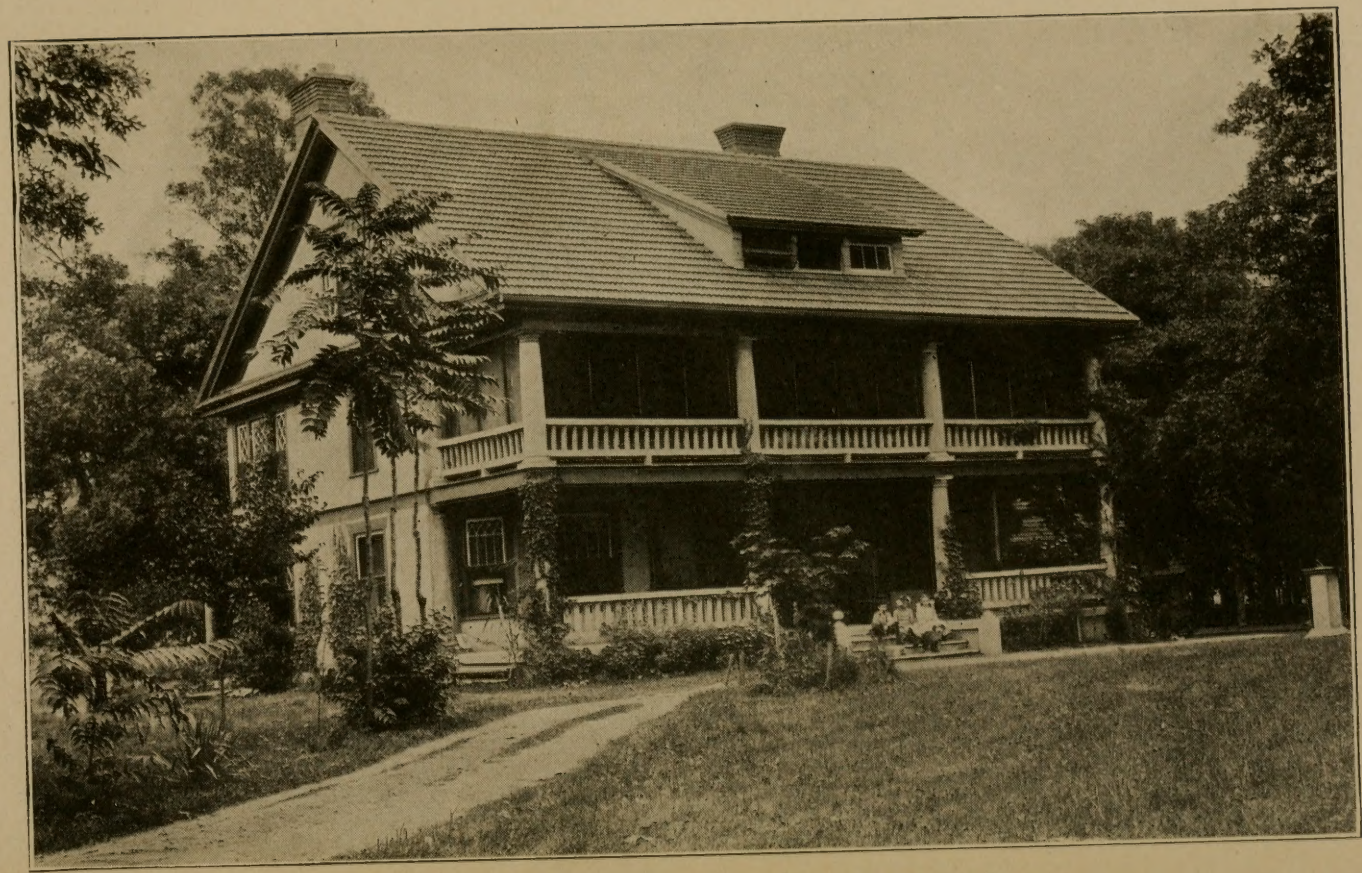
MEADOWS AND PASTURES

BY

JOSEPH E. WING



"Where the Author Lives and This Book Was Written."

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AND
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By JOSEPH E. WING
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LIST OF ILLUSTRATIONS.

Next in importance to the divine profusion of water, light and air, those three physical facts which render existence possible, may be reckoned the universal beneficence of grass. Lying in the sunshine among the buttercups and dandelions of May, scarcely higher in intelligence than those minute tenants of that mimic wilderness, our earliest recollections are of grass; and when the fitful fever is ended, and the foolish wrangle of the market and the forum is closed, grass heals over the scar which our descent into the bosom of the earth has made, and the carpet of the infant becomes the blanket of the dead.

Grass is the forgiveness of Nature—her constant benediction. Fields trampled with battle, saturated with blood, torn with the ruts of cannon, grow green again with grass, and carnage is forgotten. Streets abandoned by traffic become grass-grown, like rural lanes, and are obliterated. Forests decay, harvests perish, flowers vanish, but grass is immortal. Beleaguered by the sullen hosts of winter it withdraws into the impregnable fortress of its subterranean vitality and emerges upon the solicitation of spring. Sown by the winds, by wandering birds, propagated by the subtle horticulture of the elements which are its ministers and servants, it softens the rude outlines of the world. It invades the solitude of deserts, climbs the inaccessible slopes and pinnacles of mountains, and modifies the history, character and destiny of nations. Unobtrusive and patient, it has immortal vigor and aggression. Banished from the thoroughfares and fields, it bides its time to return, and when vigilance is relaxed or the dynasty has perished it silently resumes the throne from which it has been expelled but which it never abdicates. It bears no blazonry of bloom to charm the senses with fragrance or splendor, but its homely hue is more enchanting than the lily or the rose. It yields no fruit in earth or air, yet should its harvest fail for a single year famine would depopulate the world.—*John James Ingalls.*

Consider what we owe to the meadow grass, to the covering of the dark ground by that glorious enamel, by the companies of those soft, countless, and peaceful spears of the field. Follow but a little time the thought of all that we ought to recognize in those words. All spring and summer is in them—the walks by silent scented paths, the rest in noonday heat, the joy of the herds and flocks, the power of all shepherd life and meditation; the life of the sunlight upon the world, falling in emerald streaks and soft blue shadows, when else it would have struck on the dark mould or scorching dust; pastures beside the pacing brooks, soft banks and knolls of lowly hills, thymy slopes of dawn overlooked by the blue line of lifted sea; crisp lawns all dim with early dew, or smooth in evening warmth of barred sunshine, dented by happy feet, softening in their fall the sound of loving voices.—*John Ruskin.*

PREFACE.

The genesis of this book was a ride across England one day in May, 1907. The earth was green and beautiful, the pastures lush, the meadows giving brave promise. Many cows grazed the pastures, fleecy sheep climbed the hills of Derbyshire, great mares watched their lubberly colts race across the sward and all was one harmonious scene of peace, restfulness and security. There was something especially alluring in an agriculture based essentially on permanent things like meadows and pastures that do not let fields erode, that maintain and build fertility, that make possible the higher types of agriculture based on keeping good animals, on making milk for babes, wool for soft garments or fine young horses for the use of man.

All along the way I observed there was much doing in the meadows. Great hopper-shaped machines on two wheels were going to and fro over the grass distributing something, I knew not what. Evidently the grasses were being fed; evidently the wonderful carpet of green did not "just happen"—it was part of a definite plan. It was fed, with what?

I learned a great deal during that summer in Europe of the habits of men in feeding grasses in that land, in making and maintaining meadows and pastures. All my life I had loved grasses and clovers, the meadowland and the pasture, as had my fathers and grandfathers before me, and this work appealed to me. I resolved to help on the same sort of work in America. My book "Alfalfa in

America" was the first step, and was a labor of love. With that book out of the way, I took up this one and have labored on it intermittently ever since. I am conscious of its imperfections and limitations, and can only plead that in America the work of learning what can be done with meadows and pastures is so new that I can not find data.

Let me here give thanks to the men who have helped me. On my table has lain constantly Beal's "Grasses of North America." "Spillman's Farm Grasses of the United States," Thos. F. Hunt's "The Forage and Fiber Crops of America," and every known bulletin of the various states of America and the Department of Agriculture. I have also drawn considerably from E. B. Voorhees' "Forage Crops." In truth, it has not infrequently come over me with wonder, "Why, here is better material than you can present; Why not tell your readers to go directly to Beal, Hunt, Spillman or Voorhees rather than to read a book of your own?"

I do, indeed, earnestly advise each reader to buy all of these books. They are all valuable, each one in its own way. Nevertheless, I have been able here to add, I hope, a little to the sum of knowledge of grasses and clovers, their care and the feeding of meadow and pasture land, so that maybe this book will find use on American farms.

INTRODUCTION.

I sit to write this book just as spring comes timidly sweeping over the land. Winter has been long and cold, the naked cornfields are sodden, gullied with winter rains; there is no hint of life thereon. Wherever the plow held sway last summer there is rueful countenance today. I look out across wide stretches of meadow and pasture land. There already the ground is covered with greenness, the tiny grass blades are pushing up, the clovers are coming, too, the soil is alive, the field is a living thing, robing itself with green. On the cornlands there has been waste during winter. The rains have washed; the fertility has leached away. Not so with the fields of grass and clover; they have more than held their own; they are richer, not poorer, for the lapse of time.

Pastures feed mankind; they are the bedrock of civilization. From my window I see cows tranquilly grazing the short, tender grass under the lee of the hill—the grass that the first sun has warmed and made sweet. Those cows are the foster-mothers of the human race. They are alchemists, transforming the green carpet of nature into milk yellow with cream, food for mankind, making sturdy limbs of childhood and brain, muscle and endurance in man. Children love the wide pastures, the sunny, grassy slopes. The largeness, freedom and sweetness of the grassy outdoors build the child. The cow comes homeward with swinging udder filled to nourish,

to build, to replenish the mother, the strong sons, the little toddling children. Truly their flesh is grass.

In another pasture I see white-fleeced sheep; I hear the tinkle of their bells. Eagerly they nip the tender grass and the budding clovers. Their lambs race on the hill-slopes; a grave-faced man with stooping shoulders walks among them, giving each ewe and each lamb a searching glance. Under one arm he carries a dangling lamb, one of new-born twins, wandered from their mother. Presently he unites the little family and with satisfaction sees the mother ewe own her lamb, and with true maternal instinct proceed to fill it with milk. Its little tail wags a joyous story; the shepherd smiles and goes on his way. The pastures clothe mankind.

The races of men who wear wool dominate the world. The keeping of sheep has made characters so strong, so brave, manly and true that they have changed the history of the world. Moses keeping his father-in-law's flock on the desert ranges of Midian dreamed there dreams, gained strength, faith and persistent courage that enabled him to lead the children of Israel from bondage to the Promised Land. Young David, watching sheep on the hills of Judea, gained strength, courage and farsighted wisdom that led him to be the deliverer of his people, their greatest king and singer. There is something that comes from living amid pastures that makes men sane, patient, enduring, imbued with deep love for their land and their country.

Carrying farther the thought of the influence of pastures on civilization, I see grazing on the hillside a mare and a foal. While the sheep clothes and helps feed man-

kind the horse gives him his strength. By means of the horse he subdues forests, emerges into new lands which he makes into states, plows, plants and reaps fields of maize or of wheat, drag harvests to the railways that carry them to the hungry peoples of the world. The horse creates highways and maintains them, creates commerce, creates and carries food, fuel, clothing—all the things that go to make up the needs of man. While the sheep comforts mankind and the cow nourishes, the horse makes man what he is—strong, swift, bold, daring. And all this comes from the pasture.

In the past we have not esteemed pastures as we should. We have with our pastures an inheritance of neglect. In the beginning when fields were carved with infinite toil from forests, the maize was fenced, the wheat enclosed, the animals were turned outside. That land which had received no labor was made pasture. Since then we have followed a like practice; all our labor, all the manure, all the lime and drainage, go to the plow land, the pasture receiving nothing. The richest, most level and best-drained lands are plowed; what is too rough or too poor or too wet is made into pasture. In the northern and middle states grasses come of their own accord, so on pastures none are sown. The owner knows little or nothing as to the profit derived from this pasture. Very likely he will tell you that it has no profit at all, only convenience. Year by year the grasses grow of their own accord; they require no sowing, no expense save fencing. No credit is given for gallons of milk produced from this grass, for pounds of butter, for growth of young pigs, colts, lambs and calves. The work horses run on the

pasture at night, but the owner forgets to credit the pasture for helping in their upkeep and conducing greatly to their health. When he has his plow lands well under hand, he turns longing eyes toward his pasture, and probably sets the fence in so that he can plow a slice of it and add it to the field. It is doubtful whether he has any acre of plow land that is making him more clear profit than the same width of pasture land, yet he knows it not. It has never occurred to him to drain his pasture land, to feed it, to lime it perhaps, and make it more profitable.

The purpose of this book is to bring this matter of permanent grass and clovers, the meadows and pastures, before farmers, helping them to see the profit that may be had from them, helping them make two blades of grass grow where only one grows now. It is high time. The year of 1910 witnessed almost a famine in many cities, with foods so high in price that men, women and children have made great outcry, and with good reason. The way to feed the people is not to plow more land, but better to till what land is plowed. To feed the people we must first broaden our permanent pastures, and make them more productive. An acre of bluegrass has produced 500 pounds of beef in Virginia. An Illinois cornfield with a 40-bushel crop (above the average for that state) would make fewer pounds of beef or pork. The Virginia pasture is not eroding and is losing its fertility at least much more slowly than the land planted to corn, given cultivation and exposed for seven months to leaching and washing of rains. I know grazing farms in Virginia that have yielded $15 per acre in beef and lambs and colt flesh. Laying down lands to pasture or

meadow is not going backward in civilization or development. The growth of our cities makes call for more milk, cream, lambs, pigs, calves and colts. We can lay down a fourth of our corn acres and with feeding and good culture grow more on the remaining three acres than we have been accustomed to grow on the four. By the aid of the land laid down to pasture we can become in a measure independent of distant sources of supply for animals to feed. The pasture land will make our lads better linked to the soil. A boy is not easily fastened to a plowed field; his affections are not deeply set on a corncrib or a grain bin. The pasture, with its inhabitants, the frolicking lambs, the bright-eyed calves, the sturdy colts and great, gentle mares—these touch his heart and make him glad to succeed his father on the old home farm.

Withal there is such deep ignorance of the art of making, holding and feeding meadows and pastures in America that I have thought it well worth while undertaking these investigations and seeking to help what I could. Before I began this task I addressed a letter to each experiment station director in the United States asking for help. It was amazing to see how many replied in effect, "We regret that we have made no investigations along the line of work about which you inquire, and have no record of ever having fertilized any pasture or permanent grassland." Beside these letters, I did receive many most helpful ones not only from home, but some even more inspiring from abroad. In the Old World one finds pastures most prized, best fed, best cared for; there already men have begun to learn

the art and science of making two blades of grass grow where but one grew before. I wish this book to be as short, simple and concise as will go with accuracy. I promise to leave out of it everything that my conscience will permit me to leave out.

There are 3,500 species of grasses in the world and 6,500 species of legumes. All of these are interesting. Life is so short that we shall here consider only those that have proved their merit. The list is a surprisingly short one both of clovers and grasses.

THE GRASSES (GRAMINEOE).

Probably the grasses are the most useful plants in the world. It may be that more than half the individual plants in the world are grasses. It is a great family of more than 3,500 species, embracing species that are so tiny that they hardly reach an inch in height, and the giant bamboos of the tropics that sometimes grow to be 100′ or more. Corn is a giant grass; and wheat, rye, oats, barley, rice and sugar cane, all are grasses. Then there are millets, sorghum, Kaffir-corn, broom corn—all grasses. Some few plants we call grasses are not true grasses; the sedges are of a lower order of plants. Broom sedge is not a grass.

One can know a grass usually by its round often hollow stem, its long, narrow leaf with usually parallel veins and its manner of growth, not from buds at the terminus of the part, but by leaf and stem being pushed up from beneath. All grass stems are jointed; the nodes are bulging and usually solid. The leaves clasp the stems in enveloping sheaths.

Most grasses, especially the perennials, have creeping underground stems or root-stocks. These make new stems to spring up around the parent stem and thus perennial grasses usually thicken themselves rapidly. Some annual grasses do this and some do not; nearly all grasses "stool" or increase by sending up many stems from one root. Wheat may send up 40 or more stems from one seed if the soil is rich; corn will sucker, sending up sev-

eral stalks, as will the sorghums, millets and all those classes of large grasses. Some species send out long trailing stems or runners lying flat on the earth and taking root at each joint. Some, like the quack grass (*Agropyrum repens*), fill the soil with a mass of roots that will each send up new stems and if dragged to a fresh spot will there make a new center of growth.

The number of species of grasses is enormous, yet we have adopted into our system of agriculture but a few sorts. In part that is due to the ease or difficulty of seeding grasses. Timothy grass, for example, is so easily sown and the seed so easily gathered, that it is soonest set of any, and has become the standard hay grass of northern climes. In some regions Kentucky bluegrass is the almost universal pasture grass because it comes in of itself; in other regions with different soil (poor and lacking in lime) redtop has possession. Naturally the farmer follows the line of least resistance, yet it is by no means certain that he has adopted into his agriculture all the best grasses that nature has provided.

On the mountains and hills of Utah, for instance, once grew wild bunch grasses that would keep cattle fat all winter, standing dry, yellow and cured on their stems. We have not yet learned to use that bunch grass in cultivation; maybe we shall never learn it. In Ohio the wild grass of the open plain, blue joint (Calamagrostis Canadensis), made far more hay to the acre than timothy does, and I think the hay was fully as good. Some day we shall do more towards using now neglected species; their seeding habit is what is now in the way.

On the other hand, many grasses listed as useful are

not in use, and there must be good reason for this. Some of the little used but recommended grasses are not easily established. Sheep fescue, for example, I have always found most difficult to establish in Ohio, though the few plants that I have succeeded in getting have grown well. So of a number of the other fescues; while they may be useful grasses in their place, yet the part they play in American agriculture is negligible, with the exception of Meadow fescue (Festuca pratensis). While one may doubt the wisdom of the individual farmer, here and there, yet there is no denying that collectively, as a mass, they have followed the lines of least resistance and, as a rule, found the plants that will give them best results. There are exceptions to this rule. For example, in most of the states north of the Ohio River brome grass (Bromus inermis) seems to me to be the best of all pasture grasses, yet because it does not come of itself it is as yet almost never seen. So, too, the reed canary grass seems unusually prolific and productive, but because of difficulty in seeding it is seldom used.

HOW GRASSES FEED.

Grasses have wonderful root development. Their fine, fibrous roots penetrate deeply into the soil and occupy each tiny crevice. I have seen barley roots penetrate 8′ into loose loamy soil in California before the tops had reached 12″ in height. These tiny rootlets have great power to absorb; some of them have power even to dissolve. Grasses use a good deal of silica to stiffen their stems. This silica is sometimes dissolved from grains of quartz sand. Some silica-loving plants will even etch

glass that comes in contact with their roots, dissolving it to obtain their building material. Grasses have great power of absorbing whatever fertilizing materials there may be in the soil. Their roots cluster thick wherever there is food, finding any decaying material in the soil and nesting there in multitudes. There seems indeed a subtle intelligence in nature; it is almost as though the grass roots were alive, for they seem to seek out and find the desirable feeding places in the soil. The fact probably is that they penetrate nearly every crevice in the soil, but unless they find nourishment they do not thicken and increase. The way grass roots find their way through the soil is interesting. The tip of a growing root has a constant motion to each side, so that as it pushes forward it feels its way, entering every open channel.

This explanation explains only in part, for the fact is that the roots of a plant persist in keeping a more or less direct course away from the stem, spreading in every direction much as the branches do above ground. Were there not some subtle intelligence in nature the roots would double back on themselves and tangle inextricably. They very fully occupy the soil and to far greater depth than is often supposed, especially if the subsoil happens to be permeable and fertile. This explains why underdrainage helps grasslands and why grasses so thoroughly use up soil moisture during periods of drouth.

Plants absorb the moisture and available plant food of the soil, having also the power to dissolve locked-up, mineral plant food. There are four elements that the plants mainly need in soils, (the others usually being in plenti-

ful supply and so of lesser importance in considering the fertility of a soil). These elements are phosphorus, potassium, nitrogen and calcium. It is notable that soils seem to select their plants, or vice versa. One finds in a certain soil one type of grasses, in another soil a very different type. Where lime abounds, with phosphorus, potassium and nitrogen, one sees the Kentucky bluegrass occupying all the land, no other species being able to maintain a foothold. In a soil poorer in lime and phosphorus Canada bluegrass will be found, and where lime is markedly deficient with also a scarcity of other mineral elements (they usually go together) redtop predominates.

Clovers gather nitrogen from the air through the action of bacteria that inhabit their roots. Grasses have no such affinity for bacteria, and no means of gathering nitrogen. Grasses feed largely on nitrogen and soon take it out of the soil when kept closely cropped or mown off for hay.

GRASSES AND CLOVERS SHOULD BE GROWN TOGETHER.

Because clovers have power to provide nitrogen they and the grasses should always be grown together. Indeed, this is nature's way. There is commonly seen in nature an intermixture of plants and none more perfect or adapted to good ends than the mixture of grasses with clovers. One often sees an old pasture become thin and the grasses somewhat feeble, then white clover appears and overruns it. The clover finds mineral elements sufficient and the grasses weak and off their guard. After the clover has grown well there for a time the soil is filled with nitrogen once more and then the grasses spring up with renewed vigor and the clover is subdued and nearly

suppressed. When the grasses have again exhausted part of the available nitrogen and become less vigorous the clover reappears, and so the endless round of nature goes on. Timothy yields much more hay when red clover is sown with it than when sown alone; Bermuda grass thrives best when white or bur clover is grown with it, for any clover will secure nitrogen from the air.

AN OLD SOD IS RICH.

"To break a pasture will make a man, to make a pasture will break a man," is an old English saying. It is well known that sod ground is rich, especially rich in nitrogen. Grasses will not yield their maximum till they have accumulated a "sod." What is a sod? It is a tough fibrous mass of roots, stems and decaying leaves; half is alive and half is dead. It is made up of all the plants that grow on the pasture—grasses, clovers and weeds. It may be as tough almost as a carpet, and can be cut and rolled like a green rug. Sods contain much nitrogen. How do they get it? It was not till 1901 that we knew of a group of beneficent bacteria that live on decaying vegetable matter in the soil, the "azotobacter." This group of bacteria revels in old pasture sods; the bacteria like a soil rich in decaying vegetation, with enough lime, with air in plenty and moisture enough. It is through these azotobacter that old sods, even when clovers have been absent, are yet rich in nitrogen.

PRODUCTIVITY OF PASTURES.

Old sods often have double the carrying power of newly-seeded grass land. The reasons for this may be various, yet one chief reason is in the presence in the old

pasture of a sod, a dense mass of decaying stems, leaves and rootlets, with their accompanying bacterial flora adding nitrogen to the soil to promote life in the living stems. The lesson is plain; do not overstock young grassland; let it grow rank enough so that part of the grass may fall to the ground and decay to start the development of these life-giving bacteria. The work may also be greatly expedited by scattering manure over the newly-made pasture land.

DO PASTURES BECOME "SOD-BOUND"?

A common belief among farmers is that pastures fail to produce as well as they should sometimes after standing for a term of years because they have become "sod-bound;" that is, too many plants are established to a square foot. Probably this is seldom, if ever, true. The pasture declines not because of over population but because of the using up of its available plant food. To test the matter, take the worst bit of dense pasture sod you can find and feed it, either with manure or with nitrate of soda (at the rate of about ¾ pound to the square rod) and see if it does not at once immensely improve and grow perhaps four times as much forage as will grow on the adjoining land unfertilized. To plow that sod, killing the grasses and letting their stems and roots decay in the soil, would also fill the land with nitrogen, but it would take years to restore as good a set of grass as was already there, needing only to be fed.

HOW GRASSES GROW.

A curious and distinguishing trait of grasses is their manner of growth. Most plants grow from the unfolding

of terminal buds, and the continual formation of new buds at the tips or sides of branches. Grasses grow from the lower ends of their leaves or blades; thus, you may cut off the grass blades as often as you like and they will again be pushed up from below. This curious fact is of the greatest value, as it makes possible the pasturing of grasses with no injury to them. Clovers fed down close yield only a fraction of their normal growth, since they can not after being bitten off grow again till new buds are formed, while grasses bitten off will, if there is moisture and warmth and fertility under them, at once push up the bitten blades high enough to afford a second bite, and this they will do indefinitely.

HOW GRASSES THICKEN.

Grasses tend to increase by means of their spreading underground rootstocks. These rootstocks are not true roots, but are in reality underground stems. Some grasses are very wonderful in their development of underground stems, providing very stout, stiff, powerful rootstocks armed with hard, sharp points able to penetrate almost anything. It is not unusual to see a root of quack grass penetrate entirely through a potato. A large number of grasses have these creeping underground stems, Kentucky bluegrass, brome grass, redtop, and Bermuda grass being good examples. There are other grasses that tend always to remain in clumps, as the fescue grasses, timothy, orchard grass, and western bunch grass. Even these stooling grasses increase, but the new offshoots are always sent up close to the parent stem.

This tendency of grasses to thicken themselves makes

it easy to get a good thick sod. One need not sow more seed after one gets a sprinkling of grass; one needs only in some way to increase the fertility of the soil either by manuring or fertilizing or by sowing legumes, and in a short time nature will plant the grass plot so thickly that no room will be found for more plants.

SOME GOOD GRASSES FOR MEADOW.

Timothy.—More has been said for and against timothy grass than almost any other grass or forage crop. It has been lauded as the best feed for horses. It has been denounced as the poorest forage coming from the meadow. It has been declared unfit for sheep or cows because of its deficiency in protein. It has been declared to be no better than straw in a ration for cattle or horses. Livery stable keepers refuse to buy any other hay for their hard-driven horses. Many men declare that horses will work better on timothy hay than on alfalfa or almost any other hay. The fact remains, after all has been said, that timothy is, and will long remain, the standard hay crop of America. There are several very good reasons for this fact. It is very easily established; the seed is cheap and easily sown. It comes soon and yields its best crop, very likely, the year after it is established. It is an easy grass to make into hay. It has fair palatability and horses once accustomed to it relish it. It is not very nourishing when cut as ripe as is common practice, and thus there is no bad result from feeding horses plenty of it; in truth, they will not ordinarily eat too much of it, as it is not sufficiently palatable to tempt them. Contrasted with alfalfa, it has far less of nourishment in it, but alfalfa is often

Timothy (Phleum pratense).

fed in too large amounts to horses and the excess of nutriment fed them must be eliminated and that fact makes them sweat more and tire sooner than had they not been overfed. The plain truth is that timothy hay is safest for horses ordinarily because it is not much more than a filler, the animals getting nourishment from grain.

When to Cut Timothy Hay.—Timothy hay is not a suitable forage for dairy cows, fattening animals, or sheep; it is too woody and unnutritious for that unless it is cut early. Early-cut timothy hay is tender and digestible. As it ripens it becomes more and more woody. Prof. H. J. Waters, when Director of the Missouri Experiment Station, made some very valuable investigations as to the effect of harvesting timothy hay at various stages of development. Briefly, it was mown when in full head but not in bloom, when in full bloom, when the seeds were formed, when the seeds were in the dough and when the seeds were fully ripe and some of them shed. It was expected that a large increase in yield of weight of hay would be found as ripening progressed. This did not prove to be true. The tests were carried through several years and varied in results considerably, yet usually neither the first nor last cutting made the greatest weight of hay; sometimes it fell to that cut when in full bloom, sometimes to that with seed just formed and in one instance to the cutting made before bloom. Usually there was considerable shrinkage in the hay cut before bloom. The evidence, judged by weight alone, seems to point conclusively to cutting just when the seeds are formed. Cutting at that time also produces hay of the highest market quality.

Digestibility and Time of Cutting.—There is another factor than yield to consider, especially if one is to feed the hay to one's own animals; that is, palatability and digestibility. Early-cut timothy is tender, well-flavored, easily masticated and digested. Animals like early-cut hay and eat it readily. Late-cut hay is tough, woody, hard to chew and hard to digest. If one succeeds in getting a great weight of hay cut with seed fully ripe one has little if any more than so much straw. A great deal of the protein that should be in the hay has gone into the seed, and animals can not digest timothy seed. The plants have developed a great deal of woody fiber and that has locked up much nourishment that otherwise would have been available.

Green grasses are full of sap; that sap is the best part of the grass. Everyone knows the good that follows putting animals out to graze tender, juicy grass. Grasses cut with the sap in them, dried and made into hay, will maintain animals nearly or quite as well as though they were grazing it green. My father knew that well, and by cutting his meadows early, he would usually be through haying by the time his neighbors had begun. He often told me that early-cut grass would feed young cattle as well as ripe grass and grain. His practice proved his theory. He always wintered young steers on hay alone and they grew well and came through in good order, afterward grazing exceedingly well. It was not unusual for him to cut timothy before it flowered; oftener he would cut it when in full bloom. He would always have red clover mixed through his timothy meadows so long as it would endure.

Showing the Effect of Time of Cutting Timothy On Succeeding Yield of Hay.

The Missouri Experiments.—To test this thing, Prof. Waters at Columbia fed steers on timothy hay alone and gave them their choice of the several cuttings. These were put in the rack so that the steers would eat as they liked. In every instance, they began to eat the first-cut grass, taking next that cut second and refusing to eat any of the ripe cut hay till the earlier-cut was all consumed. The instincts of animals are very safe guides when matters of nutrition are concerned. The investigations of Prof. Waters are so interesting and the results secured so valuable that I advise the reader to see THE BREEDER'S GAZETTE of June 9, 1909 and June 16, 1909. I quote his conclusions: "So far all the results have been in favor of the earlier cuttings. The yields were larger, the hay was more completely digested, and was more palatable to the stock. In the matter of convenience of harvesting the balance tips heavily the other way. The greener the grain is cut the longer time it takes to cure, the more easily it is damaged by showers and heavy dews, and the more readily it will sunburn." The fact is, however, if one is farming to feed one's animals one can well afford to face those obstacles in the hope of getting the larger nutrition from the land and of having the animals in better thrift and flesh.

Time of Cutting and the Health of the Plants.—There is another side to this question—that of early or late harvesting. Fortunately, Waters has also made this clear. It is the effect of the cutting at different times on the future yield. It has long been noted that in the drier parts of the timothy belt, the yield of subsequent crops was injured by early cutting. This is not usually true in the

eastern and moister parts of the country. Prof. Waters points out that* timothy increases by multiplication of bulbs, somewhat as some sorts of onions increase. These bulbs store food for the future growth of the plants. As the timothy ripens nutriment is being stored in the new bulbs as well as in the seeds. If it is then cut too early the bulbs are weakened and the stand lessened. These bulbs also increase and store nourishment in the fall while the aftermath is growing; therefore it is a serious injury to a timothy meadow to pasture it in the fall. Timothy meadows should never be pastured unless the aftermath is unusually heavy due to a moist fall. It is not easy to thicken a timothy stand by sowing fresh seed. Nature's way is to thicken by increase of bulbs. Good feeding will do much to keep the stand dense. Except in the moister and cooler parts of the United States, one can not expect to make a permanency of a timothy meadow; it must occasionally be plowed and cultivated for a year or more and resown. Other grasses creep in to oust the timothy, the chief offenders being Kentucky and Canada bluegrasses and redtop. These grasses being much more firmly rooted than timothy, can not be got out without plowing the meadow.

Where Timothy is Profitable.—Timothy may be grown as far south as central Mississippi if sown on rich alluvial soil; it does not endure for a long time except in cooler, moister regions. Its natural home is along the northern edge of the cornbelt, northward far into Canada throughout New England, the high parks of the Rocky Mountains with irrigation, and the rainy side of the Pacific

* The Breeder's Gazette, June 30, 1909.

Coast states. In the central states timothy thrives for a few years, but tends steadily towards replacement with other grasses. Timothy responds to rich, moist soil, well filled with decaying vegetable matter.

What to Sow.—Perhaps no other grass has been found that affiliates well with timothy, and any admixture will lower its grade in the market. On poor soils deficient in carbonate of lime, redtop thrives better than timothy and is sometimes sown with it, though redtop is an inferior grass. Clovers grow well with timothy and are an aid to it. Common red clover suits it best under ordinary conditions, though on moist land inclined to need lime alsike clover is more vigorous, and on dry, rich soils alfalfa and timothy thrive well together. Unfortunately the market objects to a large proportion of clover in timothy hay, though if it is nicely cured the hay is really very much enriched by the mixture. Red clover disappears after the second year quite completely and there is no doubt that the yield of timothy is materially increased by having had the clover as an associate. Timothy rapidly uses up the nitrogen of the soil, and this the red clover accumulates.

Alfalfa with Timothy.—Where one grows timothy for one's own use one can well afford to sow with it alfalfa, since the alfalfa will greatly enrich the timothy as hay and will also make it grow the more vigorously. To accomplish the mixture, however, one must sow the two seeds together, either in August or in spring, or else establish the alfalfa first and later sow the timothy. We may sow alfalfa alone in April or May or June, depending on situation and the season best adapted to alfalfa

sowing; then in the fall, after the alfalfa has been harvested, one can harrow in timothy seed with every hope of a stand. In the course of three years the timothy will rather get the upper hand of the alfalfa, unless the land is especially well adapted to alfalfa, yet that fact need not deter one from sowing them together, as when the alfalfa is gone the timothy will be more vigorous than if it had not been sown with it. Another method of sowing timothy and alfalfa together is to sow them very early in April on well-prepared land. In this case a seeding of a bushel to the acre of spring barley may be used, which will be cut for hay when in bloom or soon afterward. If the timothy should seem a little thin in the fall a bit more seed may be sown then. It is useless to sow alfalfa except on well-drained land that has in it plenty of carbonate of lime. It is true, however, that any land that is just right for alfalfa is right to make a maximum crop of timothy as well. The mixture of alfalfa and timothy comes far nearer being a balanced ration than either of the plants used alone.

Method of Sowing Timothy and Clover.—Timothy is usually sown in the fall with wheat or other fall sown grain. Hardly any crop is easier established. Given a good seedbed and a fair degree of fertility and the timothy seed sown with wheat in September or October, one will secure a stand in nearly every instance. It is usual to sow with a grain drill having a separate grass-seeding compartment which scatters the seed in front of the drill, though some prefer to have it fall behind. It is largely a matter of how the weather behaves that determines which practice is best.

Quantity of Seed.—The amount of seed used is from 4 to 20 pounds per acre. Very thick stands are less productive than normal stands. Probably a rational seeding for ordinary soils and seasons would be one peck or 11 pounds to the acre. The clover is added in the spring. There are several methods in vogue to get a catch of clover in wheat that has been sown to timothy. The usual method is to sow about 10 pounds to the acre of clover in March when the land has been honeycombed by frost, depending on the frost to cover the seed. Another and better plan, so far as the clover is concerned, is to wait till the land can be harrowed, say in April, and then to sow the seed and harrow sufficiently to cover it slightly. With care this can be done with no marked injury to the timothy and with marked benefit to the wheat.

Mixtures Produce the Most Hay.—Very much more forage can be taken from land seeded to mixtures of grasses and clovers than when any one plant has exclusive possession of the soil. Thus timothy and clover produce more than would timothy alone, and if more than one species of clover is put in it will yield more than if red clover alone is the consort. Alsike clover may be added, a sprinkle of alfalfa, some mammoth red clover and some redtop. Orchard grass and brome grass ripen too early to be sown with timothy. Meadow fescue added in the spring will help somewhat. It is really astonishing the amount of herbage a mixed planting will yield, especially if the land is well enriched and has been deeply-plowed and well-prepared. The different species of plants have somewhat different food requirements and habits of feeding. The legumes can utilize the free nitrogen of the

air; some root deeper than others and thus by growing them together the whole soil and space are best occupied.

Sowing Timothy Alone.—It is not necessary nor always desirable to sow timothy with a nurse-crop. In any region not subject to very dry falls it is good practice to sow timothy and clover together in late summer, say in late July or during August. Sown thus early the grass will make a full crop of hay the next year. This it will not do sown in the fall, as there will not be time for the fall seeding to grow a crop of the bulbs on which the rapid spring growth depends. Getting a stand in late summer is dependent on good treatment of the soil. It should be plowed some time before seeding, and carefully pulverized as fast as plowed. After each rain (not too immediately after) the land must be disked well and harrowed to conserve moisture and yet more perfectly complete the pulverization. The seed must be sown when the soil is stored well with moisture beneath and in a compact, mellow condition. It must be lightly covered. Given these conditions, success is almost certain.

Feeding Timothy Meadows.—Timothy is a crop rather exhaustive to the soil. This is especially true if it is grown in nearly a pure stand without clover. The "running-out" of timothy meadows is more often the result of exhaustion of readily available plant food than of any other factor. It pays largely to feed timothy meadows and feed them well. Experience of older countries like England and Scotland is all in favor of feeding grasslands, great profit resulting therefrom. Now that the manure spreader has come to nearly every stock-farm it affords an easy way to rejuvenate a timothy meadow. At

any time after the hay is taken off, manure may be spread evenly over the meadow. Care should be taken to break up large masses so that the grass may not be smothered, and it should be spread so evenly that while all will be covered, yet the grasses will be seen peering through. If now this manure has been reinforced with something carrying phosphorus, say with acid phosphate, using about 40 pounds to the ton of manure, or with "floats," (finely-ground phosphatic rock) using 100 pounds or more to the ton of manure, the fertilization will be quite complete and very effective. No fear need be felt that the manure will damage the next year's hay crop. The rains of fall and winter will have so decayed it that it will practically have melted into the soil before another year. Eight to 12 tons to the acre make a good fertilization, though much less will serve and give marked results in the succeeding hay crop. I have taken more than 3 tons of timothy from an acre of land top-dressed with manure. The same land untreated would hardly have yielded one ton, and with hay worth $12 per ton it is plain that the 8 tons of manure applied brought return of $24 or $3 per ton. Furthermore, there was left considerable residual fertility in the soil which subsequent crops of hay and corn recovered. Where manure is not available timothy meadows are very responsive to artificial fertilization.

Fertilizers on Timothy Meadows.—Quite a large number of field experiments with fertilizers on timothy are recorded. The grass seems unusually responsive to good fertilization. Wheeler and Adams working at the Rhode Island Experiment Station reported* in 1902 experiments

* Bulletin 82, Rhode Island Experiment Station.

on meadows of mixed grasses, 15 pounds of timothy sown with 7 pounds of red clover and 7½ pounds of redtop. Following are given the yields of field-cured hay obtained, per acre, upon each of the three plots in 1901:

Nitrogenous manures per acre.	Pounds of hay per acre.		
	First crop.	Second crop.	Total crop.
Plot 17, none	3,050	240	3,290
Plot 19, with 133.52 pounds nitrate of soda	5,150	400	5,550
Plot 21, with 400.56 pounds nitrate of soda*	8,750	640	9,390

"Grass from like areas of each plot was harvested in the case of the first crop, and assorted for the purpose of ascertaining the relative amounts of redtop and timothy which were present. Following is the result of this examination:

RELATIVE PERCENTAGES OF REDTOP AND TIMOTHY UPON THE THREE PLOTS.

	Plot 17. Without nitrogenous manures.	Plot 19. With a ⅓ ration of nitrate of soda.	Plot 21. With a full ration of nitrate of soda.
Timothy	20 per cent.	39 per cent.	67 per cent.
Redtop	80 per cent.	61 per cent.	33 per cent.

"It will be noted that with each increase in nitrate of soda the percentage of timothy showed a marked gain, just as was the case with the total yield of hay. The most plausible explanation which has suggested itself for this striking result, is the influence upon the growth of the crop brought about by the soda of the nitrate of soda, by virtue of its tendency to render the soil alkaline. It will be recalled that in other experiments at this station, it has been demonstrated that redtop is capable of thriving on soil too sour (acid) to be suited to timothy and Kentucky bluegrass. When nitrate of soda is applied to soils as a manure, plants re-

*Four hundred pounds of nitrate of soda furnish about 62 pounds of nitrogen.

move the nitric acid of the nitrate more rapidly than the soda, and in consequence, the latter, which is capable of overcoming or lessening the soil acidity, tends to accumulate in the soil."

The plain lesson of this is to sweeten the soil with lime before making the meadow. Carbonate of lime (ground raw limestone) is the cheapest and best source of alkaline base for restoring the sweetness of the soil. It is interesting to see how, as the soil is fed, the inferior redtop recedes and the better grass predominates. On this especial type of Rhode Island soil (rather markedly deficient in fertility) it was found well to use potassium, phosphorus and nitrogen in the following proportions: 807 pounds of 16 per cent acid phosphate, 200 pounds of muriate of potash and 400 pounds of nitrate of soda. It is very noticeable that fertilization increased the density of the stand and excluded weeds. I again quote from Rhode Island bulletin 82:

"In 1900 the following numbers of grass stalks per square foot were found upon each of the three plots:

Plot without nitrogen, 222.
Plot with a one-third ration of nitrogen, 271.
Plot with a full ration of nitrogen, 236.

The greater quantity of nitrate of soda was an important factor in maintaining the stand of timothy probably on account of the soda left behind, by which the tendency of the soil to become acid (sour) was partly counteracted. The largest yield of field-cured hay in 1901 was 9,390 pounds, or 4.7 tons per acre, which was found to be equivalent to 7,549 pounds, or 3.8 tons, after lying in the mow until the following February. An allowance of 20 per cent. to cover shrinkage in the barn was found to be excessive except in the case of the heaviest crop of the first cutting, in which case 4.4 tons of field-cured hay were obtained per acre. The hay was, in every instance, sufficiently cured to keep in the best condition before being weighed and stored in the barn. The quantities of plant food removed by the crop were determined. It was found

that if supplied with everything else that was necessary, the following amounts of manurial ingredients were removed from the soil by 1,000 pounds of field-cured hay, free from clover:

5.6 to 5.8 pounds of nitrogen.
14.7 to 16.2 pounds of actual potash (K_2O).
3.3 to 3.5 pounds of phosphoric acid (P_2O_5).

"The early application of top-dressing is of vital importance in a dry season such as that of 1900, when, notwithstanding the severe drouth, 4.1 tons of field-cured hay were harvested per acre. At present the great drawback to profitable grass culture in New England is the neglect systematically to top-dress mowing lands and a general lack of knowledge of the relative quantities and absolute amounts of chemical manures to apply. If every one of the 78,824 acres of grass land in Rhode Island were treated in an intelligent and economical manner, the increased revenue to the state would be enormous. The facts presented ought to emphasize the importance of chemical manures."

In 1902 the experiment was continued, each plot receiving phosphorus, potassium and two of them nitrogen. Below are given the quantities of nitrate of soda applied per acre, and the amounts of actual nitrogen contained therein:

	Plot 17.	Plot 19.	Plot 21.
	Pounds.	Pounds.	Pounds.
Nitrate of soda	None.	138.12	414.35
Nitrogen in the nitrate of soda	None.	21.00	63.00

"The following are the amounts of field-cured hay harvested in 1902, upon each of the three plots:

No. of Plot.	Amount of nitrogen per acre.	Pounds of hay per acre.
Plot 17	Without nitrogen	2,950
Plot 19	With 21 pounds of nitrate nitrogen	4,850
Plot 21	With 63 pounds of nitrate nitrogen	8,200

"In 1901 a careful examination was made to determine the relative percentages of the two chief grasses on each of the three plots. It was found on the plot without nitrogen that these percentages for timothy and redtop were 20 and 80 respectively, upon the plot with one-third ration of nitrogen they were 39 and 61, and where the full ration of nitrogen was used they were 67 and 33. Similar though perhaps more marked differences were noticed this season. This is the fourth successive demonstration of the importance of nitrate of soda in maintaining a stand of timothy.

An interesting and important finding from these experiments was that timothy grown on land well supplied with nitrogen was itself richer in that element. Nitrogen is the element from which protein is largely composed and it is well known that feeds rich in nitrogen are most costly to purchase and best adapted to building body tissues in animals and to making milk. That this experiment in Rhode Island paid well the following financial results per acre in 1902 show:

	Plot 17. Without nitrogen.	Plot 19. With a ⅓ ration of nitrogen.	Plot 21. With a full ration of nitrogen.
Tons of field-cured hay	1.475	2.425	4.100
Tons of barn-cured hay	1.280	2.042	3.444
Value of crop based upon $16 per ton for barn-cured hay*	$20.48	$32.67	$55.10
Cost of the manures†	13.04	16.15	22.36
Difference	$7.44	$16.52	$32.74

"Comparing the results upon plots 17 and 19, it will be seen that an extra outlay of $3.11 for nitrate of soda on plot 19 gave an

*The actual price of hay has been considerably in excess of the value used in this estimate.

†Muriate of potash valued at $42, acid phosphate at $15, and nitrate of soda at $45 per ton, respectively. These prices are above what most of the goods could certainly have been bought for early in the season.

additional net profit of $9.08. Comparing the data in the case of plots 17 and 21, it will be seen that an expenditure of $9.32 for nitrate of soda resulted in an additional net profit of $25.30 per acre. In order to show more clearly the increase in the profits from the use of liberal amounts of nitrate of soda, the value of the crop over that of the manures is given for the plot without nitrate of soda, for that with a one-third ration, and for that with a full ration of the nitrate. These data show the results secured for the entire period of four years already covered by the experiment, as follows:

PLOT NO. 17, WITHOUT NITROGEN.

Value of the crop over that of the manures* in 1899..	$ 6.09
Value of the crop over that of the manures in 1900...	13.42
Value of the crop over that of the manures in 1901...	12.13
Value of the crop over that of the manures in 1902...	7.44
Total for the four years.....	$39.08

PLOT NO. 19, WITH A ONE-THIRD RATION OF NITRATE OF SODA.
(21 LBS. OF NITROGEN PER ACRE.)

Value of the crop over that of the manures† in 1899...	$14.34
Value of the crop over that of the manures in 1900...	20.37
Value of the crop over that of the manures in 1901...	23.97
Value of the crop over that of the manures in 1902...	16.52
Total for the four years.....	$75.20

Pasturing Timothy.—Timothy is not well adapted to being pastured. Animals grazing it close soon destroy it. The bulbs must have chance to develop and store themselves with nutriment for the following year, and pasturing would not allow this. It is injurious to a timothy meadow to pasture it after the hay has been cut. The one exception to this rule is, should there be danger of so much aftermath lying on the ground that it will endanger smothering or harbor too large a number of field mice, it may be well to pasture lightly in the fall. There is a time in late spring when the weed commonly called

*Potash and phosphoric acid. †Potash, phosphoric acid, and nitrogen.

whitetop (Erigeron annuus) appears and threatens greatly to injure the market quality of the timothy hay. If sheep are put in for a time (before the timothy is jointed) they will eat out most of the whitetop and leave the meadow clean. Care must be taken not to let the sheep remain long enough to eat down the timothy, or the cure will be as bad as the disease, unless the season proves very moist and favoring. Sheep on timothy in winter will nearly destroy it by eating the bulbs, which are tender and nourishing.

Mice in Timothy Meadows.—The common short-tailed meadow mouse is a great pest in timothy. It lives on the bulbs which are sweet and nutritious. I have found the underground burrows of these mice packed full of timothy bulbs. The remedy for mice is to have many cats about the farm, feeding them milk at the barns, to protect sparrow and other small hawks, and to scatter poisoned grain about in the meadows where their runs abound, doing this so far as possible in such manner as not to destroy innocent wild birds and domestic animals. Quail seldom if ever eat shelled corn which mice greedily devour.

Do not Clip Timothy too Close.—Close-cutting of timothy meadows is most injurious to them. I have tested this thing well and have nearly destroyed meadows by very close cutting. At least two of the lower joints of the stem should be left if the future good of the meadow is considered.

The Life of a Timothy Meadow.—There are soils so well suited naturally to timothy grass that meadows of it may endure thereon for many years. Ordinarily, in

the cornbelt region, timothy is more profitable the first and second years after sowing than it ever is afterward. Kentucky bluegrass runs into it wherever the soil is fairly rich in lime. Timothy declines in vigor, owing no doubt usually to lack of feeding and to hard pasturing in the fall after hay has been cut. Doubtless with good feeding on suitable, moist, rich soil in cool climates timothy can be kept for six or even 10 years, but for most farmers its profitable life will be found to be but two, three or four years; then it will need plowing and the land planted to some other crop allowing good clean cultivation, with enriching, after which the timothy may be resown.

Timothy as a Bridging Pasture.—While not a good grass for permanent pasture, except in mixture, timothy is one of the most useful crops that can be sown with other grasses where one wishes something on which animals may feed while other and slower grasses are becoming established. Thus in making a bluegrass pasture, timothy may well be sown with bluegrass and will afford grazing for a year or two while the bluegrass is becoming established.

SUMMARY.

Timothy is perhaps the easiest established of cultivated grasses. It is the standard hay grass. It is of rather low nutritive value compared with alfalfa or even when compared with other grasses, its protein content being quite low. It has, however, considerably more protein in its composition when cut early. Probably the greatest feeding value is obtained by cutting timothy when

in bloom or very soon afterward. Clovers enrich timothy hay and add much to its thrift and yield. Alfalfa grows well with timothy on dry, rich soils having enough lime. Timothy rapidly exhausts the soil of nitrogen and timothy meadows are wonderfully helped by applications of stable manure or fertilizers. When fertilizers are used they should contain a considerable amount of nitrogen. Timothy is a short-lived pasture grass and for best results as meadow should be very lightly pastured in the fall or left untouched. It is a good temporary pasture to afford feed while bluegrass is coming in.

Redtop (*Agrostis alba*).—It is curious how plants find their best-suited environment; each one has its place. The place for redtop is on soil rather moist, deficient in lime and somewhat deficient in fertility. Not that redtop will not thrive in rich soil, but it will endure a degree of soil poverty that timothy and Kentucky bluegrass will not endure. When one has a soil that is not quite rich enough nor dry enough for timothy one may hope to get a vigorous growth of redtop. Indeed it will almost grow in the water. Redtop is a slender grass somewhat of the type of Kentucky bluegrass but taller-growing, with a creeping underground root-stock which makes it spread rather fast and soon form on suitable soil a dense sod. It grows 2′ or more high and yields from 1 to 2 tons of hay per acre. It makes good pasture. It is not so soon established as timothy but increases in thickness for several years after sowing. Redtop is a variable grass, assuming new characters in each different situation. In England it is declared to be of little growth. In New England it is considered a good hay and fine grazing.

Redtop (Agrostis Vulgaris).

Prof. J. B. Killibrew declares that in Tennessee "It will grow upon every soil and give more general satisfaction than any other grass. It is scattered over the whole state of Tennessee. The writer has seen it growing vigorously on the highest mountains of east Tennessee as well as in the deepest valleys, on the sandstone soil of the Cumberland table land and on the cherty soils of the highland rim. It sparkles in the beauty of its verdure on the limestone soils of the central basin and acquires its largest growth in the sandy river and creek basins of west Tennessee. There is no place in Tennessee in which it does not prove a profitable grass to the farmers."

Redtop will grow as far south as New Orleans and in north Louisiana is sometimes sown for pasture and hay; it will yield well on the moist bottoms throughout all the South. While it makes good grazing it is not so nutritious nor so well liked as bluegrass. It is, however, much more adaptable to soils and climates than bluegrass. It contains more protein than timothy. Animals commonly prefer timothy and farmers prefer it because it yields more. Redtop, they say, is a good grass when one is not ready to get a better one. It has the widest range of any grass in America, from the gulf to the northern limits of agriculture in Canada, from the Atlantic Seaboard (where because of lime shortage in the soil it is common) to the high meadows and parks of the western mountains.

To oust redtop and get timothy or bluegrass instead, one has but to drain, cure the acidity of the land, and make it fertile. Ordinarily the use of 2 to 8 tons to the acre of finely-ground raw limestone or 2 to 3 tons of air-

slaked lime will restore the alkalinity of the soil, and then manure or fertilizers will afford food for the better grasses. As redtop holds the land in a dense growth, it may be necessary to plow, till and reseed in order quickly to displace it. Redtop is not to be despised and when one's land is not ready for a better grass or one's climate favors, one should utilize it. Garman of the Kentucky Experiment Station reports in comparative yields of fresh forage. Redtop, 4.80 tons to the acre; Bromus inermis, 7.20; Orchard grass, 8.40; Timothy, 7.12; Canada bluegrass, 2.64; Kentucky bluegrass, 4.08. It is evident then that the generally conceded superiority of bluegrass over redtop lies in its greater palatability and somewhat superior nutrition. It is notable that while analyses in America report redtop to be fairly nutritious, at least as much so as timothy, in England it is disliked and denounced. Sir J. B. Lawes says: "It flourishes most on dry soils and is a troublesome weed on arable land, disliked by cattle and sheep. It is reported as useless and should be discouraged as much as possible. In manuring the land the proportion of this grass was very much reduced in every instance, a result certainly not to be regretted."

To sum up opinions concerning redtop, it is not a grass of first quality; it suits certain soils, and is adaptable as to climates. It thrives in high mountain valleys and on wet land and on land deficient in lime and fertility. Drainage, limestone and fertility will bring in better grasses.

Quantity of Seed.—Redtop seed in the chaff weighs about 10 to 12 pounds per bushel, the recleaned seed 35

pounds. It is commonly sown with wheat in the fall, 10 to 15 pounds of recleaned seed or double that of seed in the chaff being used. It may also be sown alone very early in spring or with a nurse-crop of oats or barley which should be mown off for hay when in bloom.

Orchard Grass (Dactylus glomerata).—This is the cock's foot grass of England and the English colonies. It grows 3′ to 5′ high. Most of the weight of hay is from the leaves near the ground. It is one of our best grasses. It is not much in use as yet for several reasons. Orchard grass seed is not so easily sown as timothy seed nor in so abundant supply. It is, however, easy to get a stand of orchard grass and it is a vigorous, thrifty grass yielding much leafy forage and a fair amount of hay. It yields about the same amount of hay as timothy and the hay is much richer in protein if cut at the right time. As a pasture grass, it is a little richer than timothy and about half as rich in protein as bluegrass. At the Kentucky station orchard grass yielded in green forage cut June 12, 8.4 tons to the acre; dry hay, 3.6 tons. Timothy cut July 2 yielded of fresh forage, 7.12 tons; dry hay, 3.68 tons. Kentucky bluegrass cut June 11 yielded, fresh, 4.8; dry hay, 1.68. Bromus inermis cut June 17, fresh, 7.2; dry hay, 3.04. It is evident from these comparisons, which I think are fairly typical, that orchard grass is of great merit, judging it by its yield and quality. It must also be considered that orchard grass mown so early will yield a good deal of good aftermath which may be grazed with no injury to the sward, if not grazed too closely, while timothy is seriously hurt by grazing after the hay has been cut.

Orchard Grass (Dactylis glomerata).

Why is orchard grass so little used? Mainly because the seed costs more than timothy and it takes more of it. Timothy seed at present (June 15, 1910) is worth $6 per 100 pounds; orchard grass, $16, Further, it is customary to sow three times as much orchard grass seed as timothy seed to the acre. To offset this fact, it must be remembered that orchard grass lasts much longer than timothy; in truth, on suitable soil, it lasts indefinitely, and even spreads to adjacent fields, encroaching on bluegrass. I have watched the behavior of this grass in many states and am assured that it has much more value than is commonly ascribed to it. Animals much prefer to eat bluegrass or brome grass and so it is not wise to mix orchard grass with these grasses. When orchard grass is used as pasture it should be fenced to itself, not left adjacent to another pasture of bluegrass, since animals will neglect the orchard grass for the better-liked forage. It is thought that cattle will put on more fat grazing bluegrass than orchard grass. While this may be true, yet as orchard grass yields about twice as much per acre it might easily make the most pounds of beef. Henry Fairfax of Loudoun Co., Va., likes orchard grass and makes horse pastures of it. His horses are as good as are produced anywhere. On the other hand, his neighbor, E. B. White, destroys orchard grass and replaces it with bluegrass. Both men are very successful, which is a curious illustration of the difficulty of reaching truth from observing the farm practices of others.

On Woodland Farm we have one pasture of orchard grass that carries annually a great burden of live stock. Orchard grass is a rank feeder, and this pasture is occa-

sionally covered over thinly with stable manure. Here it has been observed that while animals graze the orchard grass well they gnaw close the spots where bluegrass grows. After orchard grass gets old and rank, say by the middle of June, animals do not like to graze it. Rank spots in pastures should therefore be mown and made into hay, after which the fresh new grass will be grazed as it comes up and the field will be thus eaten off together.

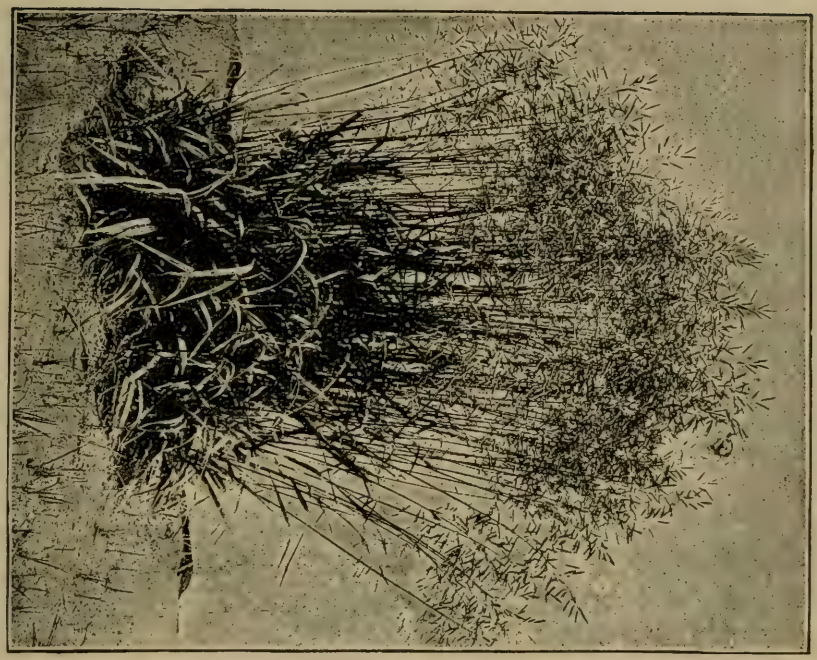
Growth of Orchard Grass April 10 in Tennessee.

I have observed that where a great burden of grass was left on the land all winter, it sometimes smothered out the roots, so there is no economy in not using it either by grazing or mowing or both.

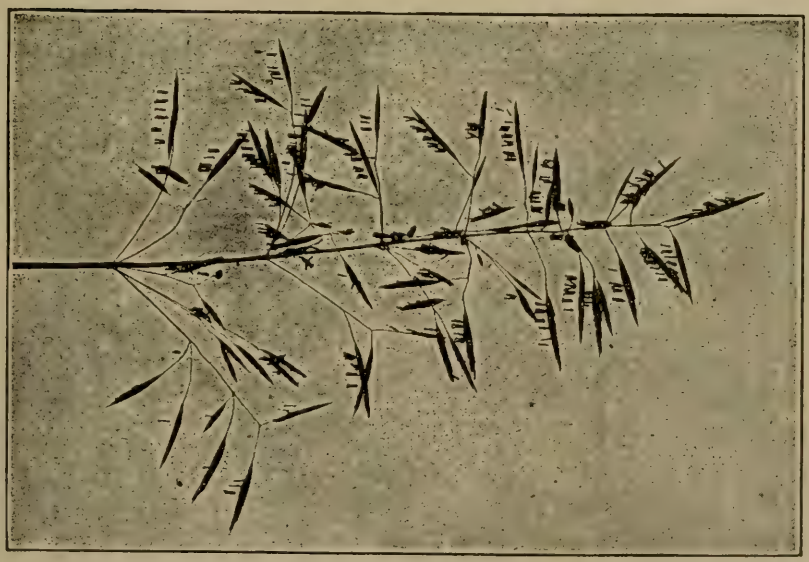
It will not do at all to mix brome grass (Bromus inermis) with orchard grass, although at first thought it would seem an ideal mixture, as the brome grass has a great tendency to thicken up by underground stems while orchard grass is inclined to grow in bunches. The chief

objection to mixing these grasses is that animals like brome grass so much better than orchard grass that they will not touch the latter while they can get the brome, which is soon weakened by too close grazing and finally nearly disappears. When used as a meadow, this mixture would do very well.

Brome Grass (*Bromus inermis*).—Brome grass is of rather recent introduction from Europe. It is prized in south-eastern Europe for both hay and pasture. It was introduced by the Department of Agriculture and disseminated throughout the West and Northwest in the hope that it might prove adapted to the semi-arid regions. This hope has been in part realized. It is fairly drouth-resistant. It will not make much growth during dry weather, but it survives to grow when rain comes. Brome grass makes considerable hay of nutritious quality if cut early. It is hardy and one of the first grasses to start in spring; nor is it cut down by frost till all else is killed. As a pasture grass in regions adapted to its growth, it is doubtful whether there is a better. It out-yields Kentucky bluegrass by 100 per cent, and animals like it fully as well, often indeed preferring it. The forage is tender, juicy and sweet. Brome grass is a vigorous perennial with stems 2′ to 5′ high, rather broad blades like oats, slender seed stalks, a wealth of leaves lower down and a habit of making a good deal of second growth of blades after being mown off. It has a habit of thickening and spreading by strong creeping root-stocks, so that a thin stand soon thickens and indeed the danger is that the sod may become so interlaced with roots and the stems so crowded that the growth will be very short. When the grass thus



A Single Plant of Brome-Grass (Bromus inermis).



A Panicle of Brome-Grass (Bromus inermis) in Full Bloom.

becomes sod-bound it is common to plow it or disk it thoroughly, when it will in a short time reestablish itself and produce well again.

Brome grass makes nutritious and palatable hay, if cut early, the best time being when the heads are in flower. There will afterward be a considerable growth of leaves that may be mown or depastured. Brome grass is very easily established if fresh seed is sown. I have had best success sowing it quite early in spring on a well-prepared seedbed. It should never be sown alone but with some sort of clover or alfalfa. Alone, brome grass often becomes unproductive through its exhaustion of the nitrogen from the soil; mixed with clovers or alfalfa it remains productive for a very much longer time.

Quantity of Seed.—The seed of brome grass is light, weighing about 14 pounds to the bushel and 20 pounds are commonly sown to the acre. If sown with clovers I would use less, seeking to get a full stand of clover or alfalfa and a thin stand of brome grass, after which it will rapidly thicken itself by means of its many creeping underground stems. In time it will probably take possession of the land and after a while need either fertilization or plowing and reseeding. The Nebraska Experiment Station showed that unproductive brome grass could be made to yield well by simply disking it thoroughly and sowing clover in it.

There are some dangers in brome grass seeding. One is that one may get quack grass seed. On Woodland Farm, seed sown in 1897, and received from the United States Department of Agriculture, was mixed with quack grass and brought the first of this grass to the

farm. One should buy brome grass seed from a reputable seedsman who knows its source. It has been reported that brome grass is hard to get out of land. We have not found this true, but when planted to corn the grass is readily subdued and does not return. I would not sow brome grass for meadow alone where timothy succeeds well nor in the South where it has never succeeded except in the higher altitudes. Along the western edge of the timothy belt, brome grass is well worthy of trial. It shares with meadow fescue the esteem of experimenters in Kansas and Nebraska. It is preeminently a pasture grass.

Meadow Fescue and Tall Fescue, (Festuca pratensis—F. elatior).—It is curious the way American farmers follow closely in one another's footsteps and imitate one another's farm practices. This is illustrated well in the case of the fescues. They are admirable grasses, more nutritious and palatable than timothy, larger yielding than Kentucky bluegrass, far better from the viewpoint of the animals than orchard grass or redtop, yet one can travel very far and see not one field of meadow fescue. I once rode more than half way across Ohio by automobile and scanned closely the wayside fields to see what was growing within. I saw abundant fields of timothy, many fields of red clover, a few of alfalfa, much bluegrass of two sorts, a few bits of orchard grass, more of redtop and not one of meadow fescue. It was not because the grass was not adapted to the soil, because along the roadsides it had come of its own accord, curiously enough, and oftentimes was displacing bluegrass. Probably the reason why farmers do not sow more fescues is

Meadow Fescue (Festuca Elatior).

that they are not often offered by seed dealers and when they are bought the seed may be old and poor or adulterated, so that one does not get what one desires. Certain it is that they are well worth a wider field than they now have. As it is, meadow fescue is now prized in eastern Kansas and in parts of Washington and Oregon. In Europe too meadow fescue is one of the highly prized grasses both for pasture and meadow, and is a component part of nearly every mixture. Englishmen nearly always sow grass mixtures, seldom a grass alone.

Meadow fescue is a perennial growing about 3′ high. *F. elatior* is a taller-growing species or variety. It is commonly called "tall meadow fescue" or "Randall grass" or "evergreen grass." These fescues spread rather slowly from the root, and lack that vigorous suckering habit that belongs to the poas, brome grass and redtop. They endure a long time in suitable soils, once established. It endures dry weather well. It is thus a good grass for regions a little too far west for timothy. It is "nip and tuck" between meadow fescue and brome grass in the esteem of some western farmers, though brome grass has the advantage of spreading and thickening when one gets a partial stand. These grasses do not yield so much hay as timothy. Practically speaking, I think meadow fescue should be in all meadow mixtures and in most pasture mixtures. It associates well with other grasses and endures for a long time in the soil, far longer than timothy.

Quantity of Seed to Sow.—The seed of meadow fescue weighs 22 pounds to the bushel; of tall fescue 14 pounds. If sown alone a bushel of seed would be none

too much for an acre. It seems that the great place for these fescues in America is in mixtures.

Sheep Fescue.—While not a meadow grass, we may as well mention this little grass at this time. It makes very dense tufts of narrow, rather hard, deep green, almost blue blades with rather few seed stems. It grows about 1′ high. It is frequently advised as a good grass for poor pastures and for sheep. I recall with lively interest climbing steep hill pastures in the south of England that were carpeted with this grass and that were so slippery with it that I could hardly stand. The sheep seemed to eat the cultivated crops in the folds below to the bare earth, leaving their fescue almost untouched. In an effort to have a good example of it on Woodland Farm I have sown considerable seed with the net result of a few scattered plants. It is apparently of no value except as an admixture for poor pastures. Garman reports, however, that with him it yielded at the rate of 2.24 tons of dry hay to the acre, at Lexington, Ky.

The Rye Grasses.—Of the Loliums there are about 20 species, distributed about the north temperate zone. Of these two are in use through cultivation, *L. perenne,* and *Lolium perenne, var. Italicum,* or perennial rye grass, and Italian rye grass. Neither grass is much in use in America. The Italian rye grass is at best a short-lived grass, living but a year or two; the perennial rye grass lives for two to five years and by seeding itself seems to live longer.

Rye grasses are easily established and make a rather large amount of hay. The perennial rye grass is com-

Sheep Fescue (Festuca ovina).

monly called "English" rye grass. It is largely in use in England but almost unknown in America except west of the Cascade Mountains on the Pacific Coast. Animals prefer rye grasses to most other cultivated grasses, the seed is usually good and the grass makes a great amount, as much as 40 bushels to the acre, so that the farmer can save his own seed with ease if he likes. On the irrigated plains of northern Italy rye grass makes great crops and in England and Scotland where there are irrigated farms it is employed and makes as many as four cuttings in a year of very heavy forage. Spillman says that the sewage meadows near Edinburgh grow rye grass and yield enormously; also that it is grown much in western California, Oregon and Washington on the moist dyked lands.

Rye grass was one of the earliest grasses adopted into culivation. Spillman remarks that the early English husbandmen at first made no attempt to separate the various grasses but grew them altogether. Later they began saving the seed of rye grass and it has been popular ever since. It is said that it was taken to Europe from England. The Italian grass sown in the fall makes a fine winter lawn for the South, and is considerably used in this way.

From my observations, the rye grasses are probably desirable in mixtures for pasture and meadow, and have hardly received the attention that they deserve in America.

Quantity of Seed to Sow.—The seed weighs 20 pounds per bushel and commonly about two and one-half bushels are sown to the acre. Rye grass is in

Italian Ryegrass (Lolium perenne).

America not so very productive. Garman reported a yield of 2.24 tons to the acre for Italian rye grass and 2.32 tons for perennial rye grass. This is not encouraging when smooth brome grass made 3.04 tons, orchard grass 3.6 tons, and timothy, 3.68 tons.

Tall Oatgrass.—According to Hunt, tall oatgrass *(Arrhenatherum clatius)* is closely related to the common cultivated oat, and also to the common wild oatgrass *(Danthonia spicata)*, which forms a portion of the herbage of permanent pastures and meadows on the poorer soils of the North Atlantic states. The tall oatgrass is a fibrous-rooted, erect, tall grass growing on suitable soil 3′ to 5′ high, with a long open panicle bearing two-flowered spikelets. It yields an abundance of coarse forage, and will grow on rather sandy soils where other grasses do not thrive so well; but in the United States its lack of palatability has prevented its extensive cultivation. It is known in France as ray grass, where, as in other parts of Europe, it is highly prized. The seed is principally imported, but it can be easily harvested. It may be bound, cured in shocks, and threshed as in case of common oats.

Quantity of Seed to Sow.—There are 150,000 seeds to the pound. About 50 pounds of seed with a germinating power of 70 per cent are required to sow an acre. Garman reports a weight of dry hay of 4.08 tons per acre. He also says:

"Among from 40 to 50 forage plants kept growing on the Kentucky Experiment Farm for a number of years, tall oatgrass has always, winter and summer, been one of the finest in appearance. In the matter of hardiness

Tall Oatgrass (Arrhenatherum avenaceum).

and productiveness it has no equal on the farm. It stands drouth better than timothy. It has not been affected by the severest cold weather we have had during the past six years. It grows rapidly on poor soil. When fully grown about the middle of June it is often 5′ in height, with a panicle somewhat like that of oats, and inclined to droop a little, but not so coarse. After flowering it soon becomes rather woody and should on this account be cut promptly before the panicles mature. After cutting, a new growth of blades appears, that might furnish either pasture or hay. The experience of American farmers who have tried this grass is in its favor, but British farmers say it is bitter and unfit for either hay or pasture. It is at least worthy of trial in Kentucky."

Johnson Grass.—Johnson grass is a sorghum, *S. halapense.* It masquerades under a good many names, as Means' grass, Arabian millet, Egyptian millet, Syrian grass and others. It comes from the Orient. In 1835 Gov. Means of South Carolina obtained seed from Turkey. A few years later William Johnson of Alabama began praising it and distributing the seed. Had he but known its future he would have been very slow to spread its seed. It is a coarse grass, with thick stems, usually about 3′ to 6′ tall. It has a head somewhat like broom corn, though much smaller, with sorghum-like seeds. The rootstocks are large, often ½″ in diameter; creeping and branching, they have a way of ramifying all through the soil and each joint can produce a new plant. It is a terrific weed when once it gets into a cultivated field. A prodigious amount of labor may fail to exterminate it once it is established. At the same

Johnson Grass (Sorghum halapense).

time it makes fairly good hay when cut green. It should always be cut for hay before the seed forms, else it is almost criminal to sell it or move it about the country. But there are places where Johnson grass is profitable. It thrives in the dry plains of Texas, and makes much pasturage and hay on which cattle are fed. It has a curious need of being plowed up now and then, else it becomes sod-bound and the roots too close to the surface to thrive. When this occurs it is only necessary to plow the land and harrow it well as though one were about to destroy the plants entirely and presto! there springs up a new, fresh stand which is soon as thick as ever.

In order to keep Johnson grass productive one must get some sort of legume to growing with it. On suitable lands alfalfa is doubtless the best legume for this purpose. Sometimes alfalfa not only holds its own but actually causes Johnson grass to disappear; in other soils Johnson grass in a few years gets the upper hand of alfalfa.

It is sometimes said that Johnson grass enriches land. If the field on which it grows is kept mowed or eaten off by animals it can hardly fail rapidly to deplete fertility, since it gathers no nitrogen from the air and in fact nothing except what it takes from the soil. Sugar planters bitterly deplore the presence of Johnson grass in their fields, and one has declared to me that the labor of cultivated sugar cane was fully $20 per acre more in fields infested with it. I can not, therefore, advise its sowing anywhere that cultivation may sometimes be desired and yet it is probably the very best hay grass

yet found for our southern states. To tell of Johnson grass and not tell how to get rid of it would be to incur the dislike of most of my southern readers. First let me advise careful buying of field seeds, especially of alfalfa seed, which is sometimes infested with seed of this grass. Next consider its habit of growth. It is a plant of the tropics; it can not endure freezing; any roots turned up in the fall so that they freeze will be destroyed. This alone will destroy Johnson grass in Ohio, Illinois, Kentucky, Missouri, Tennessee and the northern ends of all the Gulf States. The fact is, farmers in the South are not often provided with suitable plows for combatting Johnson grass. The ordinary one-mule plow only tickles and invigorates it. Spring-plowing does not much hurt it. Each joint of the long, creeping root-stocks will grow if left in the ground. Hogs, by the way, thrive on these succulent root-stocks.

Prof. W. J. Spillman has made a careful study of Johnson grass and its extermination and declares that it is conquerable. He says:

"The difficulty of dealing with this weed is greatly increased by the implements used for tillage on many southern farms. To check the grass effectively a good two-horse turning plow is absolutely necessary, an implement not found on many small farms. In plowing it is necessary to cut and turn over every inch of the land. By doing this it is entirely possible to plow a Johnson grass meadow in spring, harrow out the rootstocks and make a good cultivated crop the same year; but it requires careful work, and a great deal of it, to do so. The grass may be entirely eradicated in a single season if the farmer can spare the land and afford the necessary labor. The best way to do this is to plow the land with a turning-plow in the fall, selecting a time when the soil is mellow. Harrow out as many rootstocks as possible and remove them from the

field. Then sow some winter grain, such as oats, barley or rye. Wheat is too late in maturing. The grain should be cut for hay in the spring, and the land plowed again immediately and thoroughly harrowed, as in the fall previous. Then every time the most forward bunches of grass reach 4″ to 6″ in height, run over the land with a heel-scrape or any other implement that shaves off the surface of the soil. To be effective this shaving process must be so thorough that every sprig of grass is cut. If this is kept up till October every vestige of Johnson grass will be destroyed. It may come again from seed next year, but the seeding plants may be killed, like any other weed, by thorough cultivation. Care should be taken not to let any of them get large enough to send out rootstocks before destroying them. Some badly infested farms have been freed from this pest by the above method. The usual practice is to take one field at a time for this treatment, taking several years to extend the work of eradication over the whole farm. With a rational system of crop rotation, and the thorough working of the soil common in the north of England and in many parts of this country, Johnson grass would not be a pest, but a valuable adjunct to the list of farm crops. The climate of the entire Johnson grass area permits at least two crops a year to be grown on every acre of land. A crop of winter grain, hay and one or two summer crops of cow-pea hay or sorghum hay can be grown on the worst infested land, with little or no interference from the grass, if the land is thoroughly plowed and harrowed before planting each crop. Better than all, however, on land adapted to it, and this includes nearly all the worst areas, alfalfa can be sown on Johnson grass land with perfect success. To do this the land should plowed and the rootstocks thoroughly harrowed out early in the fall. If, after this, a good beating rain comes to firm the soil, all the better. Then sow the alfalfa, at the rate of 20 pounds of seed per acre, early enough in the fall for it to get a good start before cold weather. The next summer cut it promptly every time it gets high enough to make a fair crop of hay. This treatment helps the alfalfa and greatly discourages the Johnson grass. As alfalfa makes four or five crops of hay a year in the South (six to nine in some places), and Johnson grass only three, and as Johnson grass gradually declines in yield anyway, so that it yields very little three or four years after the last plowing, the alfalfa will, in a few years, be practically free from the grass. What little is left actually improves the quality of the alfalfa hay."

The difficulty in eradicating Johnson grass arises largely from the inherent quality in the human mind to let "pretty well" alone. Thus when the grass is fairly well subdued there is danger that the owner will relax his vigilance, just when he should redouble his efforts. It can be eradicated, but the nearer one is to that desired goal the more intense should be his efforts. Salt will not kill Johnson grass, but kerosene oil is said to do so; it might be an efficient aid when once the grass was reduced to a small number of plants.

Para grass (Panicum molle), and *Guinea grass (Panicum maximum)*.—These two grasses are of great use in Cuba and other tropical regions. They have been introduced in a small way into Florida and southern Louisiana. They are quite unlike in their manner of growth. Para grass likes rich, moist or even wet land. It is planted from slips or the roots are obtained. These, when pushed into the prepared soil during the dormant season, take root and send out long runners that lie close on the ground. After the ground is well covered with these leafy runners, upright stems appear. Para grass is used mostly for pasturage and makes on rich soil an astonishing amount. Guinea grass, according to many writers, is the best of tropical grasses. Of it says Prof. Frank S. Earle of the Cuban Department of Agriculture: "It is the best pasture and hay grass in the world. It is usually planted by slips. The para grass is rather a bad weed in some soils, about as bad as Johnson grass. It thrives best in low, half-swampy places. It yields enormously on lands that would not be fit for anything else."

Neither of these grasses will yield much forage on poor soils, even in Florida.

CEREALS AND ANNUAL GRASSES FOR HAY.

There are situations where it is best to sow some grass that will make a crop of hay soon after sowing. There are regions where summer drouths make perennial meadows impracticable, and there are emergencies on most farms that make it expedient to sow some seed that will quickly return to the farmer a crop of hay. Quite a wide range of plants can be used for such purposes.

Wheat Hay.—In California winter wheat is the almost universal hay, besides alfalfa. It is not so much sown for hay as it is cut from the boundaries of the fields to open places for the harvesters that follow as soon as the wheat has ripened its grain. Cut before the grain has formed, or just as it is forming, the straw is full of sweet sap and the whole plant is palatable and nutritious. Horses and mules work well on wheat hay, which is, indeed, preferred by such animals to alfalfa. Barley is used in the same manner. In eastern America rye is sometimes cut for hay. In northern America oats and peas sown together make excellent forage, and while commonly fed green are sometimes cured into hay.

Time to Cut Cereals for Hay.—A principle involved in choosing the time to cut any grain for hay is that at blooming time the plant has gathered from the soil about all that it will gather; it has stored in its sap nearly all the nutrients that later will go to make the grain. After bloom, the nutrients are gathered into the grain and the stem steadily accumulates wood and

loses its nourishing qualities, while the grain gains in weight and perfection. The lesson is plain: if one wishes grain he should let it ripen; if he wishes hay he should cut before the grain forms, after bloom and while the nutritious sap is all through the structure of the plant. Then all of the plant will be eaten and none wasted. Also there will be none of the annoyance of rats and mice burrowing through the mow in search of grain.

Winter Wheat for Hay.—Probably one of the smooth wheats (not bearded) will be found best of any of the common cereals for hay. There are many varieties of wheat and one can find them adapted to almost all soils and situations. In testing wheat, oats and rye for forage in Louisiana on rich alluvial buckshot soil, I was astonished to find how much superior the wheat proved to either of the other cereals both in weight of yield and palatability. Rye, a vigorous and worthy crop in northern situations, proved the poorest of all.

Winter Wheat and Vetches for Forage.—Many experiments in Mississippi, Alabama and Louisiana have shown winter wheat and winter vetches to make the most and best forage to be mown off in early spring or during the winter in far southern latitudes of anything yet tested. Cereals and the legumes, furthermore, balance each other very well.

CEREALS FOR HAY.

Rye Hay.—Rye makes as poor hay as one could desire. If it must be used for this purpose mow it as soon as it begins to shoot, not waiting for it to head at all.

Rye as Soiling Crop.—For soiling rye has its use, especially in regions of poor soil and rigorous climate. It is always a forage deficient in protein, and its chief good is as a filler and a provider of succulence in rations.

Beardless Spring Barley as Hay.—Beardless spring barley makes an exceedingly good nurse-crop for clover or alfalfa. Its merits are that it does not usually lodge, and being not very prolific does not too much shade the young legumes. It is best cut for hay just before the grain forms, since it thus affords its maximum amount of feeding value, and, getting out of the way, gives the alfalfa or clover opportunity to grow.

Rescue Grass (Bromus unoiloides).—This grass is allied to the cheat grasses. It is hardy, makes pretty good winter grazing in the South, and has been considerably exploited. I do not see that it is any better than wheat and usually seems inferior, though the seed should be less expensive, and to some extent it will reseed itself. Seedsmen oftentimes substitute cheat seed for rescue and thus make good profit, as cheat is a weed seed that is found in large amounts in wheat and separated by millers. Spillman says that cheat is by no means as good a grass as rescue grass. Unless it is desired that the grass shall in a manner perpetuate itself by self-sowing, I should choose wheat or oats rather than rescue grass for the South. This is the "Arctic grass" of some seedsmen.

THE MILLETS.

The millets are of a very ancient and honorable family of cultivated plants. Our ancestors found them edible and began their cultivation—perhaps as early as

they did wheat. Spillman says there are four great families of millets, three of which are in common use and have been used as food for man, the most common being the so-called German millets, Hungarian grass and the like. These grasses belong to the botanical species *Chaetochloa italica.* The second group comprises the broomcorn millets. Millions of men live on the seeds of these millets, while our ancestors certainly in Europe ate the German millets, as we find their seeds in the old lake dwellings and kitchen middings of Europe. The third group comprises the Japanese millets cultivated extensively in parts of Japan and China as food for man and beast. The fourth is Pearl millet *(Pennisetum spicatum).*

Millets Dry Weather Crops.—The millets seem nearly all of them to be adapted to conditions of relative scarcity of rainfall. In the United States Spillman has shown that millets (German millet, Hungarian grass and their relatives) are mostly grown in Kansas, Nebraska, both Dakotas, northwest Missouri, somewhat in Iowa, northern Illinois, and on the black soils of Texas. Millet comes in where timothy is uncertain and forage is needed. As it is sown in the spring the land can have good culture to aid it in holding its moisture during hot, dry weather following. It is also a quick-growing crop that may be sown as late as June, perhaps on land devoted previously to some crop that failed. It is often called in as a help when one sees a hay famine impending, and in this use there is good. For a comprehensive account of the millets I direct the reader to Spillman's "Farm Grasses of the United States," and

to Hunt's "The Forage and Fibre Crops of America." They do not properly belong in my scheme of meadows and pastures because being annual plants they can not be used in any plan of permanent meadowland.

Sowing Millets.—I may say, however, that the millets should not be sown till the earth is warm in the spring. Often one will get best results from sowing in June. The millets revel in hot weather.

Quantity of Seed to Sow.—A bushel of millet seed weighs from 48 to 50 pounds. From 1 to 4 pecks of seed are sown to the acre, depending on the soil. With good soil and a good seedbed a peck of seed will produce more forage than a heavier seeding. If grown for the seed a peck to the acre is sufficiently heavy seeding. Under favorable conditions 3 to 4 tons of hay or 20 to 80 bushels of seed per acre are secured.

When to Cut Millet.—The time to cut millet hay is when in bloom and before the seed form. Millet hay sometimes injuriously affects horses fed on it because of its effect on the kidneys. When cut early enough and fed in moderation it seems a satisfactory forage for most animals. Spillman calls attention to the fact that it is somewhat richer in protein than is timothy. Millet is a heavy feeder and by no means enriches land on which it is grown. It is so rank in its growth, and shades the land so well, that it smothers out many weeds. It is said to destroy even Canada thistles and quack grass, though such reports must be taken with a grain of allowance. Doubtless it would set these pests back not a little if a good stand were obtained and it grew over them and shaded them.

The millets are not at all adapted to use as nurse-crops for clovers or other grasses. It has been my observation that many men sow millet occasionally, but few care for the crop in regular use. In Ohio I have known few men to sow millet two years in succession. Doubtless the fact that the market does not call for millet hay has considerable influence.

SUMMARY: GRASSES FOR MEADOWS.

Farm practice seems to be about abreast with good science in the matter of grass meadows. Timothy is the almost universal meadow grass and deserves the place wherever there is enough moisture, lime, fertility and not too much heat. The other grasses are almost all inferior to timothy in point of yield, ease of establishment and general adaptability to a farm scheme. In dry soils north of the Ohio River brome grass seems the best meadow grass, especially desirable for the Dakotas, Nebraska and farther west. There is danger in sowing brome grass that one may get seed of quack grass. Timothy seed is easily distinguished and not much adulterated. Orchard grass is a better grass for pasture than for hay. Redtop denotes a second-rate soil or worse. Meadow fescue has considerable merit and is well worth putting into mixtures. It seems especially well adapted to the soils and climate of Kansas.

After 30 years' study of grasses I could advise a beginner in farming whose land was located within the cornbelt no better than this: Drain your land, lime it and feed it. Sow timothy, mix with it if you choose some meadow fescue and brome grass. Sow red and

alsike clover with it. Feed the meadow each year. Mow it but once—just as the bloom falls. Pasture lightly if it grows up rank in the fall. If timothy does not thrive on your soil because of poverty or wetness, take redtop. If you wish to combine mowing with pasturage take orchard grass. If you are growing for a short term of years you may mix in rye grasses if you like; they are being steadily discarded in England, once their chief stronghold. Timothy will do the trick easiest for you, as it is easiest sown and established.

To the man in the Gulf States I would say: You may use timothy and clover also if you have rich soil; sown in the fall they will give you at least one good hay crop but you will find redtop better adapted to your climate and more enduring. Better lime your soil if it needs it and sow alfalfa; it likes hot suns and the grasses do not. Do not sow Johnson grass if you do not have it aready, but if you have it sow alfalfa with it; cut always before seed forms; it will yield you a lot of good hay—nearly better than timothy.

To the man of Oklahoma, Texas, the dry parts of Kansas, Nebraska and New Mexico, where "dry farming" is being done: Do not depend much on perennial grasses; they do not root deeply enough. You must till your soil each year in order to hold your moisture; you can make hay of wheat, oats, barley, sorghum and corn. Permanent meadows are for lands with ample rainfall. Meadows in permanent grass waste much moisture through evaporation from the surface soil. They can not be tilled without destroying the grasses that you wish to cherish.

And yet there are many splendid native grasses that root deep. Bluestem *(Ogropyron repens)* is one of our native western grasses, better than timothy, adapted to dry soils in the Northwest. So of the great bunch grass of Washington, Oregon and Idaho *(Amropyron divergens)*; it has promise for dry lands but nothing that I know is adapted to the dry, hot Southwest but annual grasses, as wheat, sorghum and the Kaffir-corns.

GRASSES FOR PASTURE.

There is a difference in the requirements of pasture and meadow. Meadows are left undisturbed by animals; they are mown off once or twice during the year and then left to grow up again. Pastures are usually fed off nearly constantly all during the growing season, and even more or less through the winter season. Some grasses are especially adapted to being so fed off: others are not. Timothy, easily the first of meadow grasses, soon disappears under close pasturing. Even rank Johnson grass succumbs to close pasturing. Little sheep fescue would hardly make enough mowing to be gathered with the rake, and yet it yields well as a pasture grass. Kentucky bluegrass, the almost universal pasture grass of America, is a poor hay grass, yet it has made 500 pounds of beef from one acre in Virginia. A good pasture grass is not injured by being tread upon by animals' hoofs. It thickens itself and heals over scars, grows up cheerfully when eaten down and yields tender, palatable nutritious herbage. In America it is common to consider a pasture a permanent thing. Some grasses improve with age, with the accumulation of a "sod," a

sort of laboratory where nature is performing mysteries.

The best pastures I know are old pastures. In England also old pastures are often highly esteemed, yet there is also a custom to lay down grass and clovers for a few years only, feeding them off with sheep or cattle. The rye grasses and fescues, indeed a very long list of grasses, are added to a pasture or grazing mixture. They do not highly esteem our all but universal Kentucky bluegrass. They complain that it soon takes possession of the land and displaces coarser and larger-yielding grasses.

Kentucky Bluegrass (Poa pratensis).

Ever smelt Kentucky grass,
  Or heard about its blueness?
Seems as if the whole blamed world
  Was bursting out with newness.

Skies and folks alike all smiles,
  Gracious! you are lucky
If you spend a day in June
  Down in old Kentucky.

—*Alfred Monson.*

Of no grass has more been said than of this. It is almost everywhere found in eastern America from far north in Canada to the Gulf States. In many places it is called "June grass"; in Maryland "green grass." Beal says it is found in Australia, Asia and Europe. It varies somewhat according to its locality. Its name "bluegrass" seems to me somewhat fanciful for assuredly its sister-grass, Canada bluegrass, is more blue. I think Kentucky bluegrass came originally from Europe. The evidence to me is found in the fact that it was not one of

Kentucky Bluegrass (Poa pratensis).

the prairie grasses of Illinois, nor seen on the rich open plains of Ohio, until white men came. When introduced into prairie regions it quite often crowds out the native grasses and afterwards, so farmers complain, yields less forage during dry seasons than did the grasses displaced.

Give bluegrass credit for having fought its own way alone and unhelped. Without any aid of man it came to the new clearing; it grew about the cabin dooryard; it carpeted the newly-cleared pasture; it enriched and beautified the roadside; it held the clayey hillside and animals cropped it and waxed fat. Not corn, not wheat, not tobacco, but bluegrass became the chief article of export from the Central West, going out disguised as beef, mutton or pork, a large part of each being of its making. Of the millions of bluegrass pastures in America only a few have ever had seed of this grass sown upon them.

Bluegrass varies much in height. I have seen it 4′ high where something held it up and again blooming when less than a foot high on poor soil or in cold climate. Its fine, feathery top does not last long but dries up and is not then relished by animals. There is a great wealth of blades, however, and these do not cease to push up all summer and long after most things are frozen in the fall. The decay of these blades and the creeping roots make the sod which is often tough enough to be rolled into a roll like a green carpet.

Bluegrass spreads rapidly by creeping rootstocks and thus thickens up a thin stand. Indeed it crowds out most other grasses, give it time. Its ability to displace other

grasses depends much on the soil in which it is found. In rich limestone soils it revels, and there few things are able to keep foothold with it. Brome grass seems crowded out by it, and even that dreaded quack grass. Orchard grass seems to hold its own with bluegrass and even to spread among it. Meadow fescue grows well with it. When the soil is right, Canada bluegrass, redtop and timothy give way before it. All the wild prairie grasses yield to Kentucky bluegrass sooner or later if found growing where there is enough soil moisture.

Clovers of many sorts consort well with bluegrass. Naturally the little creeping white clover is found with it. Red clover and mammoth clover grow well with it. Alsike clover is found with it on certain soils. Alfalfa does not much like bluegrass but bluegrass likes the afalfa well and crowds in wherever it is sown. With clovers growing in it, bluegrass is at its best, makes its best yield and makes its fattest lambs, pigs and cattle.

THE BLUEGRASS REGIONS OF AMERICA.

There is a distinct relationship between the carbonate of lime content of a soil and its ability to grow good bluegrass. Carbonate of lime is one of the foundations of soil fertility—perhaps the one thing most essential and most lacking in many types of soil. Where carbonate of lime abounds in the soil there is found the most bountiful fertility. There is found a soft carpet of bluegrass over every bit of land not tilled or forested, often, indeed, carpeting the land beneath the oaks. Carbonate of lime is also the mother of the clovers and they feed the bluegrass. The reader interested in what car-

bonate of lime can do for the soil should read "Alfalfa Farming in America," where a rather close study of this important subject has been made.

Wherever limestone is found bluegrass is seen. It grows also all over the northern states, but it does not assume great importance elsewhere than on limestone. It can be made to grow on many soils by the simple expedient of heavy application of carbonate of lime. On sands in Maryland I have seen good bluegrass along the roadsides where oyster shells had been ground up by wagon wheels. In Vermont is a notable bluegrass region: some spots of it are found in New York (it grows sparingly over nearly all the state); there are fine limestone valleys where it thrives in Pennsylvania and Maryland. One reaches Virginia before one finds bluegrass enthroned as queen of all field crops. In the limestone regions, mostly in a belt running through the state from the Potomac River to the line of Tennessee, one sees splendid pastures fed by fine cattle, horses and sheep. The chief interest in the good parts of these bluegrass counties is in grazing, and the livestock fed there is exceedingly good. There is practically no other grass than bluegrass on these hills. One finds splendid examples in Loudoun, Clarke, Shenandoah, Augusta, and on down through Tazewell, Russell and Smyth counties. I have not named all the counties having fine bluegrass but enough to show the line or "pay streak" of carbonate of lime that makes the grass. In Russell county Hon. Henry Stuart has grown from a pasture as much as 500 pounds of beef per acre and had considerable fall pasture left for calves when the export steers were gone.

Virginia Mountain Pastures.

Once in Burke's Garden in Tazewell county an old man told me of the first coming of bluegrass to that mountain vale. His father was a slave-owner who grew corn, and the new grass coming unsown troubled him greatly. He had the slaves dig it up and lay it on the stumps to die, dolefully predicting that "this grass will some day run us out of the country." Instead, the grass now carpets nearly all of the valley and sends out many fine fat cattle and lambs each year.

When the Virginians went to Kentucky they unwittingly took the grass with them in their old high wagon boxes as forage for their horses or as bedding for themselves. Thus it spread along the wayside and in a few years was at home in the new, rich soils of central Kentucky. It found there a most congenial home. That soil is rich in phosphorus and rich in lime. Bluegrass grew there so vigorously that it seemed like a new plant and took the name of the state in which it grew best. It is assuredly true that bluegrass partakes considerably of the nature of the soil upon which it grows. This is true of other plants as well, but is perhaps more especially true of this grass. At least it is notable that horses grazed on bluegrass in Kentucky on the soils so rich in lime and phosphorus have a splendid bone and a wonderful stamina and endurance. They have also an almost inextinguishable goodness that is hard to define or explain. It is as true of the men and women of the region, so the underlying rocks and soil do assuredly influence what springs out of them. Ohio may on its more favored acres grow more bluegrass than Kentucky, but it seems to make softer horseflesh and poorer

Grazing in the Mountains of Virginia.

bone. Illinois grows big, juicy bluegrass but it does not make cattle fat as does the grass of the Virginia mountains.

Ohio was settled soon after Kentucky, and bluegrass came with settlement. The natural bluegrass area of Ohio lies mostly west of the Scioto River, though there are rich hills and valleys east of the river that produce the grass well. The advantages of bluegrass are that it is very hardy, is green early in spring and late in fall (it is not quite so hardy as brome grass, though); it is very nutritious and palatable; it makes much milk, muscle and fat; it is fairly productive. It yields nearly as much dry matter as the larger grasses, if we except the meadow grasses. The yield is variable, depending on moisture of the soil and fertility. Neglected and closely grazed, bluegrass pastures are often yielding comparatively little. On Woodland Farm we have tested plots with and without manures; the land unfed yielded at first cutting 6,400 pounds of green forage per acre; the manured land, 20,000 pounds.

This was the spring growth only; there would be about two-thirds as much more to come from the land during later croppings. The grass was cut about July 1.

Bluegrass for Lawns.—Wherever the soil is good and moisture can be had, north of Tennessee bluegrass is the best lawn grass. It is doubtful whether any grass added to it improves it. It is better when mixed with white clover. If the soil is poor sheep fescue and other inferior grasses may help it out. Canada bluegrass will grow on poorer soil than Kentucky blue. In Tennessee

if the lawn can have partial shade, if it has a rich soil supplied with enough lime, bluegrass will thrive. South of this state the summer suns seem too hot and Bermuda grass is better.

Disadvantages of Bluegrass.—It spreads rapidly and crowds out timothy, clovers and alfalfa. It is a little hard in wet seasons to eradicate from plowed fields, though this is not serious. It grows in the moist weather of spring and crowds out better drouth-resistant grasses. This is especially true in the western prairie states and in the Willamette Valley of Oregon, where it is complained that "bluegrass crowds out all other grasses and then dies itself of drouth."

Seeding Bluegrass.—Bluegrass seed is small; there are about some 2,200,000 seeds in a pound, yet one cannot bank on more than a very small percentage of them germinating owing to the difficulty in sowing them to a proper depth, having sufficient moisture and other favorable conditions. Hunt says that when 40 pounds are sown on one acre it puts 2,000 seeds to the square foot. I think that bluegrass will lie dormant in the soil for some time, as it often appears almost spontaneously in a meadow of timothy or alfalfa. One can not establish bluegrass except very early in spring or during cool, moist weather of fall. The seed does not germinate unless during some part of the day the temperature drops to 40°. It is cheaper and easier to establish bluegrass by sowing it with other grasses. If the grass is not already found growing wild in that neighborhood it is probably of no use to sow it at all until something has been done to

change the soil type. However, if the climate is all right the soil may be made right. Heavy liming, preferably with ground and unburned limestone (carbonate of lime), then manuring, are all that bluegrass requires to make it succeeed. In Virginia it is a custom to turn under a heavy crop of cowpeas before seeding to bluegrass. The more nitrogen in the soil the better for this crop; it revels too in humus. It is not a poor-soil grass.

One should prepare a fine, firm seedbed for bluegrass. He can hardly harrow and firm his land too well. He may sow in September with fall wheat or barley. This mixture will give good results (sooner or later the bluegrass will have almost complete possession): Timothy, 15 pounds; Kentucky bluegrass, 10; meadow fescue, 5; red clover, 7, or alsike clover, 6 pounds or, better, mix them together and sow 8 pounds, little white clover, 2 pounds. Clovers are not well sown in the fall; this mixture can be sown early in April or in late March if the ground can be gotten ready. Or the grasses may be sown in September with wheat, a very thin seeding, or barley or even rye, so it is sown very thin; rye makes too many leaves to be a first-rate nurse-crop for small grasses, and the clovers added in the spring. I really prefer the spring-sowing, as then the conditions can all be controlled nicely. Late spring seeding is useless. Timothy is the first grass to appear but sooner or later the bluegrass will crowd that out.

Mixture with Brome Grass.—Really I should prefer the brome grass mixture to that with timothy. Brome grass is as easily set as timothy, so one gets good seed,

and once it is set it makes far better pasture than timothy, more and better pasture. Indeed, it is possible that it may make better pasture than the bluegrass itself; that is a point yet to be determined. In time on bluegrass soil the brome will disappear almost completely, this because the animals eat it soonest and because the bluegrass though a smaller grass has a way of crowding in very closely, so that even the vigorous brome grass is outdone. In any event, in sowing a mixture with brome grass one is assured of good pasturage almost from the outset. The one objection to the mixture is that sometimes one buys seed of quack grass with brome grass, but this is no evil if one is to devote the field to permanent pasture. In truth, quack grass *(Agropyrum repens)* is one of the very best grasses for pasture. Nor is it very hard to conquer except in northern and ultra-moist localities. I do not find it a particularly troublesome weed in central Ohio, while in Michigan, Wisconsin and New York farmers dread it exceedingly.

Coming now to seeding bluegrass with brome grass, I suggest early spring as the best time. The land is well to be plowed during winter or else disked up with no plowing at all. Manure will help; use it as liberally as you can. I should sow then 20 pounds of bluegrass, 10 pounds of brome grass and a mixture of clovers according to the soil. Sow with it also 5 pounds of timothy if you like; it will help thicken the sod at first. Do not mix orchard grass with this seed as it does not give brome grass a fair show; animals relish the brome grass too well to eat orchard grass while it is to be had.

Methods of Sowing the Seed.—Having the fine, firm seedbed I suggest drilling into it one bushel to the acre of beardless spring barley, afterward sowing the grass mixture by hand. To cover the seed sufficiently a brush harrow is good. One can readily make this by fastening small, stiff, wiry branches to a brace, or even drag brush over the field—anything that will not dig deep or cover seed deep. Mind it is done early in spring. Observe afterward how much finer a stand you have where you have applied the most manure. If no manure is available and one wishes to stimulate the young grasses one may apply before sowing the seed commercial fertilizers. Bonemeal will do wonders—say 400 pounds to the acre, or the same amount and 100 pounds of nitrate of soda. In truth, the use of bonemeal or phosphatic fertilizers of some sort has been well proved to be a first-rate agricultural practice when establishing grasses.

Sowing Bluegrass with Alfalfa.—If I wished to establish the very best possible bluegrass I would forget the bluegrass and prepare the land exactly right for alfalfa. Then when the alfalfa has been sown and established I would know that the bluegrass would come in tremendous vigor, even if no seed were sown at all. Naturally it would come in better when seed was sown, say 15 pounds of alfalfa, and at the same time in early April 20 pounds more or less of bluegrass. In England the best farmers have learned that there is nothing else so good a preparation for grass as alfalfa.

Improving Bluegrass by Sowing Alfalfa.—Similarly, it is a great scheme to sow alfalfa on an old bluegrass

sod. One first drains the wet places in the pasture, plows the land in early spring, disks and harrows it and sows to alfalfa with a good dressing of fertilizer. It takes well on such a seedbed. In two years there is a splendid mixture of alfalfa and bluegrass and in four years the heaviest of bluegrass and not much alfalfa left.

Example of Successful Seeding.—In 1900 we bought a clay hill field above our own land. It had not been in grass for half a century. It was beginning to wash and gully badly and the clay was covering our better kept soil below. We had little expectation of profit from this field for many years, believing that regeneration would be slow. There was no available manure for it. We therefore bought commercial fertilizers, mixing them ourselves. Acid phosphate and tankage were the ingredients, the tankage being slaughter-house waste, dried and ground, the acid phosphate the bones of pre-historic animal life, treated with sulphuric acid to make it dissolve in the soil and available to plants. We disked the field very early in spring and as deep as we could, then drilled in about 300 pounds per acre of this fertilizer. We sowed two bushels of barley per acre and right behind the drill a mixture of grass seeds; there were brome grass, orchard grass, timothy, Kentucky bluegrass and white clover. After sowing the seed we rolled it with a 2,200-pound roller, bringing it down to a firm condition, so that the moisture would come clear to the surface. It proved to be a dry summer. When the barley grew up about 18″ we turned in sheep which ate it down; then we took them off. Their tiny feet yet further firmed the soil.

Later in the season they were turned in again for a few weeks—not long enough to eat the young grass close. In the fall cockleburs came thick with other weeds. We put the mower over the field. Stock was kept off in the winter and at wet times, as there was only the young grass and no sod as yet. In the spring of 1902 we put the manure spreader over the entire field. The grass came on well and thickened up wonderfully. That old scarred hillside became a mass of thick grass and white clover. It pastured a great deal of stock—sheep, cattle and colts. I have no doubt that it yielded us at least $5 per acre. And each year since it has done better, for the grass is now firmly rooted. The bluegrass is gradually rooting out most of the other grasses. White clover has been luxuriant over all the land. That is because of the acid phosphate which we applied. Clover has also stored the soil with nitrogen, which the grasses take up and use. Men seldom sow white clover because they say it will come in of itself. That is true, but it does not pay to wait; better sow the seed and get immediately what would take years to accomplish in nature's leisurely process of seed-growing and distribution. It does not pay to allow nature to do one's farming.

I write now in July, 1910. The foregoing account of the old field was written seven years ago. That field has continued to give us great profit and has taught us some lessons. For one thing, we now know better than to mix brome grass with orchard grass. There is now little indeed of the brome grass left; it is mainly a field of orchard grass and bluegrass. It is not well to mix

orchard grass and bluegrass. Each should be in separate fields.

Mixing Orchard Grass with Bluegrass.—The result has been that animals like the bluegrass so much better than they do the orchard grass that the bluegrass is kept grazed too close and the orchard grass let grow too rank and tall. Nevertheless, the bluegrass is steadily encroaching on its competitor. Orchard grass is a tremendously good grass, but sow it in a field by itself where it will be fenced so that animals must eat it when they are turned to it.

Securing a Maximum of Bluegrass.—Not many men understand how to manage a bluegrass pasture; in truth, they seldom give it any thought at all. It is assumed that pastures should care for themselves and be always cheerful carriers of all the animals that can be piled on them. The following principles of good management the author has observed: Feed animals on the sod in winter when it is not wet enough to tramp into mire. Use the manure spreader to cover thinly the poorer spots in the field. Keep animals religiously off in early spring; let the grass not only start but grow till there is a good, rich, sweet bite. In latitude 40° May 10 is early enough to turn on bluegrass pasture. This one feature is of great importance—more than is often realized. Grasses are half-killed by being gnawed to the very earth in spring when they are seeking to re-establish themselves after a long, cruel winter. The carrying capacity of a pasture may be nearly doubled by observing this rule, though it requires good management to accomplish it.

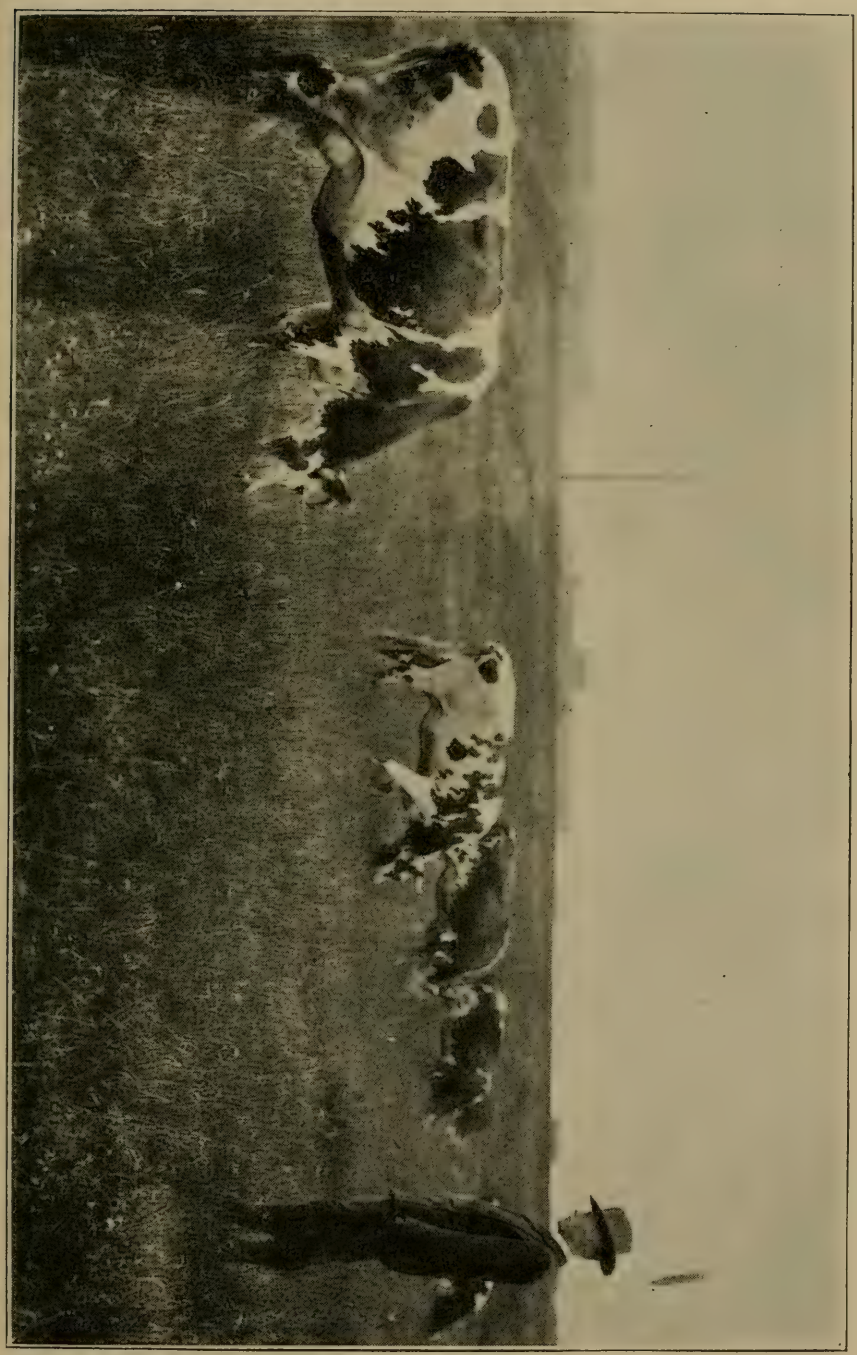
Export Cattle on Bluegrass.—"Have enough grass so that the cattle can never eat more than two-thirds of it; have enough grass for 20 and put on it 15; let the grass cover the pasture so that it shades it and prevents the land drying out in summer. If you find you have too much grass when the cattle are gone fat in the fall you will be able to feed it off during November and December with younger cattle. Enough grass for three and two eating it will make export cattle." This is the advice of one of America's most successful cattlemen who owns thousands of acres of mountain pastures in Virginia. Indeed, the one item of leaving the grass long so that it will mulch the soil and keep it moist is worth a great deal, though grass too long is not relished by animals as is shorter, sweeter, fresher blades. From my own observation, I urge the use of the manure spreader on bluegrass pastures, the use of phosphorus, of clover seeds when needed, of keeping animals off till pastures can start in spring.

How Bluegrass Came to Ohio.—The settler came with much toil and trouble into the woods of Ohio. He chose a dry little hill in the woods for his homesite. Below the house there bubbled up a spring. After the cabin walls of log were reared and roofed the spring was dug out and walled with stone. Then clearing was begun. The first crop on the fresh-cleared and burned land was wheat or corn. About the sole crops undertaken were wheat, corn, flax, and buckwheat. Hay was cut from the marshes from native wild grasses. Cows were turned outside the clearings to browse in the woods. Each little

Virginia Bluegrass Makes Superior Export Beef.

herd had its bell-cow which signalled constantly the whereabouts of the herd to the boy whose mission it was to bring them home to be milked. Sometimes the boy got lost in the woods while hunting cows. One nearly grown young man who lacked woodcraft was lost several times and finally his father gave him a compass with instructions that if he found the cows they would surely lead him home; if he did not find them the compass would tell him the direction. Yet he was again lost. Searching parties found the trail of the boy and cows, going the wrong direction, then of the boy alone, he having abandoned the cows. When they overtook him he was miles in the wilderness. He explained that "the dumb cows would not go in the right direction without being driven," then he got tired of driving them and they were contrary and he left them. "Later the compass itself got contrary and pointed east when it should point north."

Those cows did not find much grass. There was some woods grass, for the trees had little undergrowth beneath them. There were old clearings made by fire and Indians along the streams and here was wild grass. It seems there was no bluegrass. This first sprung up about the camp-fires of emigrants from Kentucky and Virginia. It spread slowly at first, then rapidly and occupied the roadsides, the settlers' dooryards, the fence corners, growing in the woods wherever the sun shone. It grew especially strong in southwestern Ohio, in the land west of the Scioto and as far north as Hardin county. It eventually overspread nearly the whole state. Pickaway, Ross, Fayette, Madison, Butler, Warren, Montgomery, Miami,



Greene, Clark, Champaign and a few other counties grew it especially strong and vigorous. Timothy grass was introduced and sown for meadow. Blue grass established itself in these meadows and crowded out the timothy. The national road was builded and communication with the East established more easily than before and cattle began to be a prime source of wealth. In the early '30s men began learning that there was as much profit in fencing pastures and letting cattle graze the unsown bluegrass as in anything. Later it became the most profitable industry of the southwestern part of the state. Hogs were always grown in numbers and this industry was most important, but cattle could travel afoot to Baltimore or Philadelphia.

In Pickaway, Madison, Clark, Greene and Champaign counties there grew immense estates, from 600 to 4,000 acres in extent. The timber was bur or white oak, black walnut, elm, wild cherry and ash. It did not stand very thick. There grew up after settlement thickets of hazelnut. These the cattlemen grubbed out and the bluegrass took possession of the ground beneath the trees. Immense pastures set with trees like parks of England were grazed by cattle that fattened mostly on the grass. Charles Phellis had one pasture of this nature of 500 acres as late as 20 years ago. White clover came with the bluegrass. Neither was ever sown, so far as I can learn. The cattle were sold at four or five years, sometimes as young as three years. They were mostly grown from cows kept by the settlers on the hills, New England Yankees. Many of these hill farmers were content with small

farms of 100 to 200 acres, milking cows and making cheese, raising calves and pigs, selling the calves in the fall to the big farmers of the "plains country." The hill farmer pitied the plains farmer, who was stuck down in mud and miasma, suffering plagues of chills and fever, mosquitoes, green-headed flies and rattle-snakes.

The long-headed, ambitious young men went to the plains for all that. Some of them walked there. They were men of mighty muscle and brain. They could do anything that men needed to do in that land from breaking oxen to hewing out timbers to roof a home. These men worked hard and lived long. Their sons, born in prosperous times, worked very little. Their grandsons have taken two ways of life—part of them have deserted the soil altogether, others have taken hold with about as much energy as their grandfathers had and are reconquering the soil and learning to make two blades of grass grow where but one grew in the palmiest days of their grandsires. It is a land resting now on a foundation of drain tiles. Not a farm but has miles of them. Woodland Farm has as much as 16 miles of them just at the edge of the plains country. It is a land threaded now with stone roads. It is a land of homes, of old trees, of memories that awaken pride, a land of beauty and chivalry. They say the fairest women out of Kentucky are in that land. It is a land of limestone and sturdy-legged boys, and of girls with the blush of the rose in their cheeks and the glint of the sun in their hair.

The methods of growing and fattening cattle in those early days were delightfully simple. Calves did not fare

very sumptuously the first winter. They got some nubbins of corn from the best feeders' hands. The hay was wild grass later intermixed with bluegrass and corn stover. Corn was all cut up into shocks of 144 or 256 hills. It was fed on the ground in the fields in the shelter of the timber. The second summer of the steer's life he was on bluegrass. He got round and sleek there. He had salt and good water and no more. The second winter of the steer's life was like the first except he might not get any nubbins of corn at all or he might get a portion of shock corn. He generally got rather thin before spring on corn stover, which was weatherbeaten in February and March. But he came to grass with a good appetite. He was now two years old and something began to be expected of him. He might grow fat on grass alone or he might be fed green corn as soon as it ripened, and this be continued until some time in December, or he might be fed shock corn all winter and go to market when he was three years old. Some that did not look ready to feed would be roughed through the third winter.

After the Short-horn blood came in, the quality of the cattle and their early-maturing qualities were greatly improved. In the '50s there were very good cattle leaving Ohio. In the '60s my memory begins and some magnificent cattle were fed in my country. They were larger, rougher, fatter than cattle now, as I remember it. They were far heavier. In the '70s cattle were marketed at an earlier age than had been customary and seldom were they more than three years old when shipped. The railway began to supersede the drive in the '50s.

What of the number of cattle fed then and now? It is mere guess-work but I think there are double the number fed now. There are more men at it now. There is little forest left. Cattle are no longer grown on the farms to any great extent; they come to be filled up, fattened and to go on. The land produces double what it ever did despite the roseate visions of eyes turned backward. We are better farmers and better feeders, too. We are not the mighty men of muscle our sires were, nor are we so saving and economical as they. We are making more money but we are not building fortunes as they did, nor can we so readily as they did. They were in a new, glorious land, blossoming with hopes.

SUMMARY OF KENTUCKY BLUEGRASS.

Bluegrass is the most universal of grasses, the best for lawns on suitable soils not too far south, the best for roadsides and certainly one of the best for pastures. Bluegrass loves a rich soil with enough carbonate of lime in it and sufficient phosphorus and nitrogen. It is essentially a grass of limestone soils. It affords much herbage of unusually high nutrition. Seemingly its one rival as a pasture grass on good soils is brome grass *(Bromus inermis)*. Bluegrass pays well for being fed with manure and fertilizers. It grows well with clovers, and they strengthen it. Bluegrass creeps into alfalfa meadows and the result is strong, unusually luxuriant bluegrass, though the alfalfa will be weakened. It is best sown with a mixture of coarser grasses, such as timothy, meadow fescue and brome grass, which it later

supplants. It does not grow well with orchard grass since animals eat the bluegrass too greedily, leaving the orchard grass untouched. To get the most possible out of it do not turn animals on the pasture before the grass is strong and affording a full bite, and do not during hot weather graze it down to the bare earth. Bluegrass finds summer heats and drouth its worst enemies. It enriches soils on which it grows by accumulating a sod rich in nitrogen.

Kentucky bluegrass varies in worth according to the soil on which it grows. One can hardly get the maximum yield from his soil sown to bluegrass because it is rather a shallow feeder and dries out the soil rapidly. Nevertheless, as it needs no cultivation, enriches land and properly managed affords much excellent grazing that makes the highest quality of animal life, one should reflect well before he plows up a bluegrass pasture, and should consider whether he is not seriously at fault in not establishing a new one. It pays as well to manure a bluegrass sod as any other land on the farm. There is no leaching away of fertility put on bluegrass.

Canada Bluegrass (Poa compressa).—It sometimes seems to me that this grass should really bear the name "bluegrass," as it is of a dark, bluish color, much more of a blue than the common Kentucky bluegrass. It has many common names, wire grass, Virginia bluegrass and flat-stemmed bluegrass. It is a shorter, more slender grass than Kentucky bluegrass and more nearly evergreen. Its stems do not dry up as do those of bluegrass, but remain green for a considerable time. It is

Canada Bluegrass (Poa Compressa).

rather hard and somewhat tough, but it is sweet and very nutritious. Animals like it well and cattle fatten on it. Horses especially thrive on Canada bluegrass and when it is sometimes made into hay, horsemen are glad to have a chance to buy it.

It is right curious how widely distributed is Canada bluegrass. I have seen it in northern Idaho. It is said that as early as 1823 it was found growing wild along the upper Saskatchewan in Canada. It is everywhere in the eastern states of America and as far south as Tennessee and the mountains of North Carolina. It is not a southern grass, but will endure about the same amount of heat and drouth as its cousin, Kentucky bluegrass.

Canada bluegrass is less particular about its soil than is Kentucky bluegrass. It likes clays and hard soils; it comes where the land is rather infertile and makes the best of it. Where there is not quite enough lime, not quite enough fertility for bluegrass, we find this hardier type. Sow the two together and if the soil is infertile and lime lacking, presently the Canada bluegrass will have possession and the Kentucky cousin will have retreated. Enrich that soil and it may be that the Canada cousin must retreat while the more pampered cousin comes to the front. It is a fair indication of land to note which of these grasses it supports in nature. I should say that land supporting spontaneously Kentucky bluegrass was worth about 50 per cent more than that growing Canada bluegrass; there may be even a greater difference than that. It is a good grass, though, not to be despised—grass that holds its color and freshness even

till snow buries it—a tremendously hardy grass, difficult to kill in cultivated fields and not tolerating companionship of clovers as well as does its namesake from Kentucky.

There are many soils on which it should be sown, either alone or in mixture with other grasses. Lands lacking in lime, in fertility, may take it quite well when they would not take Kentucky bluegrass at all. The best grasses to mix with it for somewhat inferior soils are redtop and orchard grass. Sheep fescue added to this will also serve well. Cattle are fattened on this grass. Sometimes where both grasses are found on the same farm cattle are first fed on Kentucky bluegrass and later in the season are turned on Canada bluegrass to finish them. It is unquestionably a grass of high nutritive powers.

Quantity of Seed to Sow.—Canada bluegrass seed is often sold as a substitute for true Kentucky bluegrass, which leads to some disappointment. It is an easy grass to establish; 15 pounds of seed sown with grain in the fall, or with timothy, will give a stand. What has been said of sowing Kentucky bluegrass will apply as well to this grass.

Canada Bluegrass as a Lawn Grass.—Where there is not quite enough fertility nor moisture for Kentucky bluegrass it may easily be that Canada bluegrass will make a very good lawn. For this purpose it should not be mixed with Kentucky bluegrass, as the two do not blend well. Sheep fescue sown with it will do very well. Seed of Canada bluegrass is usually threshed with a common thresher. The crop is mown with a mower after

the stems begin to assume a golden color. It is cured in cocks and in the mow or stack. Much seed is also obtained from wheatfields in Ontario, where the grass is cut and bound up with wheat and both are threshed together and saved.

If I had a field of cheap land growing Canada bluegrass I would consider it well set in a profitable pasture grass. If it was growing on high-priced land I should begin to work on that field with underdrainage, carbonate of lime and fertilizers till it was replaced by more productive grasses. If one is in doubt as to whether he has Kentucky or Canada bluegrass let him look at the stems. Canada bluegrass has flat stems, nearly solid, rather hard and bluish green in color; Kentucky bluegrass has taller stems, round and less strong, green and turning yellow soon after the seed forms.

I once made a grass experiment on very thin mountain land in Tennessee, quite devoid of lime. The grasses that best succeeded there were, first redtop, second Canada bluegrass and third orchard grass.

Redtop (Agrostis alba).—For a fuller account of redtop see page 42 under meadow grasses. Redtop is really a better pasture grass than a meadow grass. It has much the same habit of growth as the bluegrasses, thickening remarkably by underground stems and making a dense sod. It yields a little more herbage than Kentucky bluegrass. With Garman in Kentucky the yield was 3.04 tons of dry hay per acre, which was exactly the same yield as brome grass and a little under meadow fescue. Timothy gave 3.68 tons cut nearly two

weeks later and orchard grass cut 8 days earlier yielded 3.6 tons. Redtop is not so much liked by animals as is bluegrass, nor will they fatten so well on it. It is adapted to wetter soils than most other useful grasses, and is not such a stickler for lime as are the better grasses. It endures heat better, too, and will grow farther south than will bluegrasses. I have seen very good redtop on black buckshot soil in north Louisiana, where I am sure bluegrass would promptly perish in summer time. Nevertheless, it is not at all at home in hot countries; Bermuda grass is a far better pasture grass there. I am inclined to advise this: Do not try to force nature. Follow her lead. If you have a redtop soil and climate use redtop. If you wish to grow bluegrass where naturally only redtop grows, try drainage, limestone and fertilizer first.

Farms as Grass Experiment Gardens.—It is interesting to the student of plant life to observe how very many forms of grass may be found on almost any farm. On Woodland Farm, for example, we can find every grass mentioned in this book excepting the distinctively southern grasses, and even some of these are represented. Johnson grass has survived several winters and is yet in evidence, accidentally established. One should familiarize himself with the different species; he can do it readily enough, and if he finds a new grass that he cannot quite place he will get its identification if he will send a flowering specimen, top, stem and a bit of the root, to his experiment station. Today (July 23, 1910) I can find in bloom or just out of bloom on Woodland Farm the blue-

grasses, two or three fescues, orchard grass, timothy, redtop, tall oatgrass, nimblewill, quack grass (and a fine grass it is, too, one of the best, if only not so devilish) and brome grass—these of the important cultivated grasses, and many minor grasses beside the annuals. It seems to me one can tell just by the behavior of these grasses what is best fitted to his soil and has a chance for the most profit. With us redtop is seen chiefly in the moister places; it grows exceedingly well; we have never sown it nor, in truth, have ever knowingly sown several other things that are with us, notably quack grass *(Agropyrum repens)*. If one would accustom himself to observing even stray clumps of grass here and there on his own land he would hardly need ask any man's advice as to what was best for him to grow.

Redtop in Mixtures.—For all soils inclined to poverty or wetness, I should include redtop in a pasture mixture, putting with it Canada bluegrass, sheep fescue, orchard grass, alsike clover and little white clover. There is a peculiar relationship between alsike clover and redtop. It has been observed by many farmers that the soil that suits the one suits the other admirably.

Seeding to Redtop.—There are from 4 to 6 million seeds in a pound of redtop seed. It is smaller than timothy and is usually sown in much the same manner only it must not be covered as deeply as timothy hay. It is easily established and lasts longer than timothy. It is the best grass for sour land that one has not had time to correct with carbonate of lime. It is a sure forecaster of soils; when one sees a region given over to redtop one

knows that there is much soil acidity there and a backward agriculture generally.

Orchard Grass (Dactylis glomerata).—For description of the grass see page 46. Hardly any other grass has been more written of than orchard grass, and yet it is seldom used. It is less easily sown than timothy among meadow grasses. Animals do not eat it with the relish that they do bluegrass in the pasture, yet it has its place and has great value. Garman credits it with a yield of dry forage of 3.6 tons to the acre on June 12. In contrast, brome grass, a much more palatable and nutritious grass, yielded five days later 3.04 tons; redtop, 3.04 on June 20 and bluegrass, June 11 1.68 tons. It is evident from this comparison that orchard grass yielded more than double what bluegrass did, and experience proves orchard grass to make very good horses and cattle when grazed. It yielded practically the same as the very much more palatable grass bromus inermis, however, which would indicate that where one could choose between the two one should take the latter. Orchard grass, however, will grow on land too poor in lime and too deficient in fertility for bluegrass or even brome grass. It is easily established. The seed is apt to be good and pure and is not very dear. There is good profit in growing orchard grass seed. It roots deeper than most other cultivated grasses and stands drouth better. One can get from 150 to 250 pounds of orchard grass seed from an acre and afterward can have good pasture.

Quantity of Seed to Sow.—It may be sown as timothy is sown, and if sown alone 30 to 40 pounds of seed are

sown to the acre. I have had excellent results in sowing this grass in spring, very early and on well prepared land. While orchard grass always grows in stools it is doubtful whether one can make any gain by trying to fill the spaces between the stools, as the roots occupy the land. It should always be mixed with clovers and grows quite well with alfalfa. In sowing it with the latter one should not use more than 15 pounds of orchard grass seed, else it will too much crowd the alfalfa. Sown with alfalfa, it reduces the tendency of bloat among pastured cattle and the first cutting will be of nicely intermixed hay. The right mixture to put with orchard grass is likely redtop, meadow fescue and Canada bluegrass, always with clovers added. One must not let orchard grass grow up too rank, else the animals dislike it. One can keep it fresh and tender by mowing the rank spots in the pasture and making the coarse herbage into hay. I have seen a curious thing here; cattle and horses would come to the mown grass when in cock and eat it readily though they were running where they could get all the uncut grass they desired.

Do I advise sowing orchard grass pastures? Doubtless they may be made very profitable. They are especially useful for horses, which relish the grass more than do cattle or sheep. Simply see to it that the pastures of this grass are fenced to themselves, so that once turned to it the animals can not choose but eat it; they will then not neglect it. I think almost any stock-farmer would find one pasture of orchard grass properly cared for a profitable aid in maintaining herds, flocks and studs.

Brome Grass (Bromus inermis).—For description of this grass read page 50. I will add here that this is one of the deepest-rooted of cultivated grasses. In pervious soil its roots will penetrate 4′ to 6′. It is therefore much more drouth-resistant than bluegrass or most cultivated grasses. Brome grass comes to us from the steppes of Russia, those lands so much like our Dakotas in soil and climate. It is therefore adapted to all our half-moist lands west of the Mississippi River, and will grow well out beyond where corn grows, but as one gets far west the yield decreases according to the moisture. I have seen it growing wonderfully in eastern Washington where long dry summers are the rule. In central Ohio it has proved on Woodland Farm at least the best pasture grass we have ever tested. Animals relish it even better than bluegrass, and that is high praise. I have often seen pastures that were in part sown to brome grass and in part to other grasses eaten to the earth where the brome grass stood and left almost untouched in the other parts. It is therefore not perfectly adapted to being sown as a pasture mixture. I have seen Kentucky bluegrass entirely supplant brome grass in 12 years, mainly because animals always bit the brome grass first and closest. It will not do well mixed with orchard grass or redtop. With Kentucky bluegrass it goes fairly well, though I have observed that sheep and cattle usually eat the bluegrass last.

Thousands of farmers should sow pastures of brome grass who have yet to test it, as where it is adapted to the soil and climate it will yield probably double what

they are now receiving from their native grasses. I would not sow it for meadow in the timothy region. It does not appear to thrive far south of the Ohio River. Hunt remarks that at Ithaca, N. Y., animals relished brome grass pasture better than that of any other grass, a number of species being grown in one field. It seems to prefer a soil rich in lime. On the whole, it is a better pasture than a meadow plant.

I have found brome grass very easily established, and if the soil is good it rapidly thickens if the stand is at first somewhat thin. Spring seeding on a good seedbed, preferably early in the season, seems best. If I were to mix any grass with brome grass for pasture it would be timothy (which soon disappears), meadow fescue and Kentucky bluegrass.

Quantity of Seed to Sow.—Twenty pounds of good seed to the acre will give a stand. In sowing brome grass on cultivated lands one should be cautious in the matter of the source of seed, since it is sometimes mixed more or less with quack grass. This will do no harm for pasture; in truth, quack is one of the very best pasture grasses. I do not know which will be victorious in the struggle for supremacy, the brome grass or the quack, though if the land is plowed the brome is soon killed, and quack is left in possession. Brome grass needs clovers or alfalfa in company to make it fully productive. I have found it one of the very best grasses to sow with alfalfa where the land is to be pastured, as its presence prevents animals suffering from bloat. It is curious that while nearly all the cultivated grasses spread them-

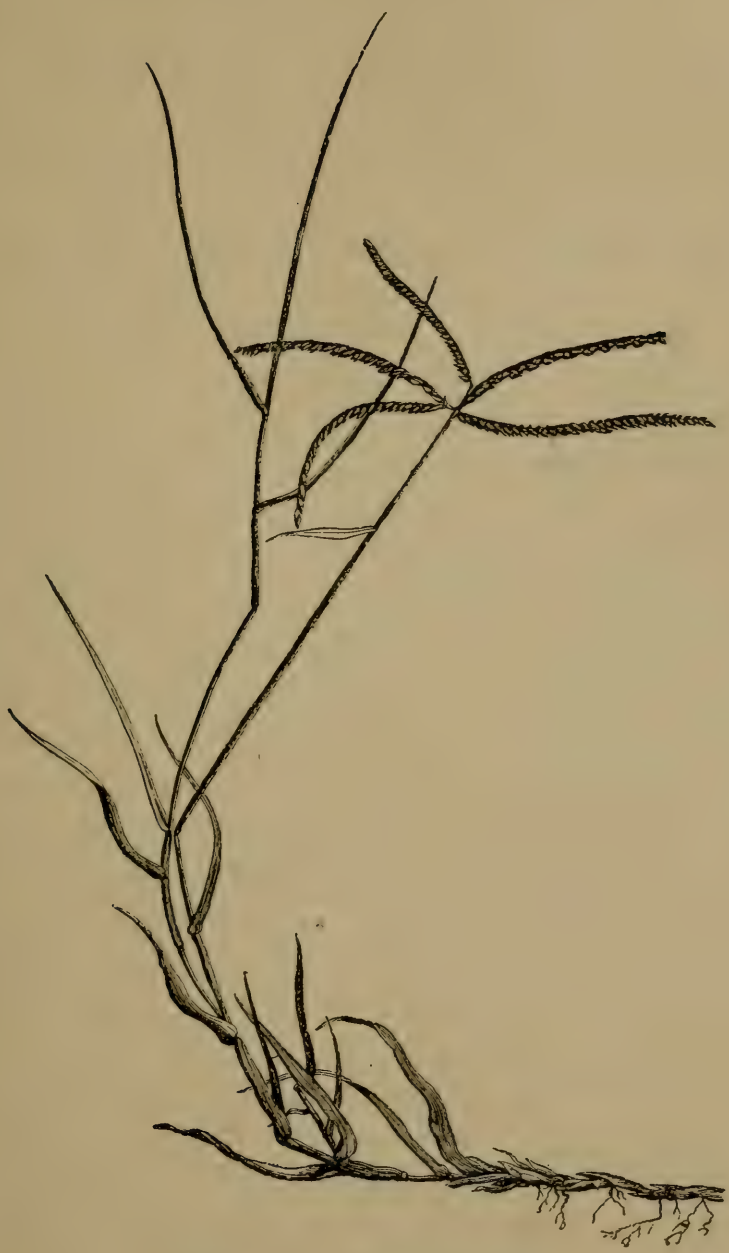
selves more or less unaided by man's intent, brome grass is seen nowhere unless sown. Yet it is tremendously hardy and able to care for itself, once established. Perhaps the heavy seeds that do not readily carry with the wind are unable to travel as lighter seeds do. Brome grass pastures will be green and give a good bite in spring earlier than any other good grass of my acquaintance, and it will endure longest in the fall. It makes very poor growth in infertile soils. Given rich land, it will make a splendid showing. It seems not adapted to southern conditions.

Brome Grass Needs to Recuperate.—L. Ogilvy, a good observer of things pastoral, says that brome grass to do its best or even to do very well as pasture grass should have a chance occasionally to grow, after which it may be eaten down again. He says that in the West he has not seen brome grass do very well when it was subject to continuous close pasturing.

The Fescue Grasses.—For a description of these see page 53. The fescue grasses are much used in England for permanent pastures. There are many species, only half a dozen of which are in common use, and these only nominally so in America. Meadow fescue, or English bluegrass *(Festuca elatior var. pratensis)* is the most worthy of cultivation and introduction into pasture mixtures. The richer the soil the more meadow fescue crowds into the pasture. It is evident, too, that animals relish it. Of all the others, red fescue and sheep fescue, it is difficult to say how much value they may have. Seedsmen list them but have so little call for the seed

that it is often old and of poor vitality when sold. Sheep fescue has much value for poor pastures unable to hold bluegrass. Sheep fescue is really a very good grass on pretty good clay soil. In making a mixture for poor soils I should include sheep fescue and perhaps some of the other species, while for good soils I should include meadow fescue.

Bermuda Grass (Capriola dactylon).—Bermuda grass is a low, creeping grass, found in the South, usually no more than 1′ high, though on rich soils it may be as much as 2′. It spreads rapidly by means of underground stems and above ground will send out stolons or long runners that strike root at each joint. In this manner it rapidly covers the ground. It is propagated by planting chopped-up bits of sod, and from its rapid spread when conditions are right it soon has possession of the land. Bermuda grass is sometimes propagated by seed, but as the seed is very costly and of uncertain germination, it is far more profitable to plant the roots. I have sown a great deal of seed under what seemed favorable conditions without getting more than 10 in a million to make plants. To plant the roots fortunately is easy. One need only plow shallow furrows through a Bermuda sod, with a spade cut the sod into bits as large as biscuits, throw them into a wagon or into barrels and take them to the field where they may be planted as one would plant potatoes, only covering not so deep. The better the land the better the Bermuda grass. It will grow, however, on rather thin soils, if it must. It is well in planting it to make a good seedbed by plowing and har-



Bermuda Grass (Cynadon Dactylon).

rowing, just as one would for a cultivated crop, then furrow in shallow furrows about 3′ apart, drop the sods, push them in with the foot and with a drag make the surface smooth again. If afterward the weeds are kept mowed, the Bermuda will within one year make a dense sod.

Bermuda grass loves intense heat. Frost kills it and freezing the roots is often fatal to it. There are strains hardier than others, and in Oklahoma there seems to have developed a strain of unusual hardiness. It is of little use after frost, as the leaves do not seem to retain their virtues in winter as do the blades of many northern grasses. Nor will it start early in spring; it awaits warm weather.

Bermuda is the bluegrass of the South. It makes a similar but tougher sod. It yields a very great amount of forage on suitable soil. It affiliates well with clovers, especially with little white clover. I feel assured that on a bit of sandy loam alluvial soil in Louisiana set to Bermuda grass and white clover, I have seen more cattle, pigs, horses and mules grazed than I have ever seen on a similar area anywhere else in the world. It is not very productive on poor or dry soils, yet it may do more than any other grass would do there. It is a most efficient soil binder where there is danger of erosion, and river levees in the South are always sodded as soon as they are completed. It will stand more or less submergence, but to be under water for a long time will destroy it. Bermuda grass is little seen north of Tennessee, southern Missouri and Oklahoma, though it is a little in

use in southern Kansas. It is not a grass for arid lands nor for regions of frequent frost. It is essentially a pasture grass, yet under favorable conditions, rich, moist soils, it may be cut for hay several times during the summer. The yield is hard to estimate. Planters have reported as much as 4 or more tons to the acre, taken in four or more cuttings. It is a grass that soon gets woody and wiry unless either mown off or grazed close. The closer it is grazed on rich, moist land the better it is. It is said that an acre of well-set Bermuda grass will carry 10 sheep for 10 months. I fear the sheep thus confined would sicken of parasites in less time than that, but it would not be the fault of the grass if they did.

It has been often said that attention to Bermuda grass would revolutionize the South. This, unfortunately, is not quite easy of accomplishment. It is not true that very productive Bermuda grass would cover all the old cotton fields and gullied hillsides. It might be made to grow there in time, and no other grass would grow there so well, yet there is no mysterious power in Bermuda grass that will find fertility where it has not been put by Nature or man. On worn soils Bermuda grass will need to be fed.

Bermuda Grass on Poor Soils.—If one has any sort of manure he is indeed fortunate, and no other preparation will be needed than to manure the land, plow it, and plant the sods. The difficulty with the South is, however, that there is usually not much manure available and recourse must be had to other means. A good preparation would be to turn under a crop of cowpeas. The

land could then be fertilized well, using whatever artificial fertilizer best suited the soil, then the Bermuda grass planted and at the right time sowing little white clover. One can not use the large-growing clovers with Bermuda grass, since it will not endure shade. It is really a tropical grass and revels in heat and sunlight. Bur clover grows with it fairly well, but white clover fits it best of all, and fortunately this clover is native to nearly all the South. Lespedeza grows fairly well with Bermuda grass and this also may be sown after the grass has been planted.

Weeds are the bane of Bermuda grass. When well-shaded it dies. I once wondered why in the dooryard lot of a southern plantation that I was studying there was not one sprig of Bermuda grass, though it was abundant on the levee bank a few hundred feet away. Later I learned that there had been a fine Bermuda lawn there for many years and only the rank weeds that sprang up during a temporary abandonment of the place had killed the grass. On the levee trespassing cows had kept the land clear enough to perpetuate the grass. In one year we re-established the grass in the lawn. It is indeed a marvel of rapid establishment on good soil. The lesson is to mow off the weeds once or twice a year while establishing the grass. Afterward, when in pasture, there will be few or no weeds to trouble. A pure stand of Bermuda and white clover, hard-grazed, on rich land, is as clean a thing as one will ever find. On thin, poor soils it will pay exceedingly well to fertilize the Bermuda pasture. I should do this very early in spring, or, if

white clover can make a winter growth, as in the Gulf States, do it in the fall. This fertilization may be of any enriching material. Acid phosphate will stimulate the clover; bonemeal is perhaps better, or one may use a complete fertilizer. The object is to make the white clover grow as vigorously during the cool part of the year as it can. While it is growing it is filling the land with nitrogen which later on the Bermuda grass will use. Do not graze the clover down close if you wish to get the most good from it. Unquestionably it would add tremendously to the wealth of the South to put Bermuda grass over a great proportion of the plowed land there. It stops erosion and builds soil. There has long been in the minds of southern men a deadly fear of Bermuda grass—fear that it could not be eradicated when they wished to farm the land.

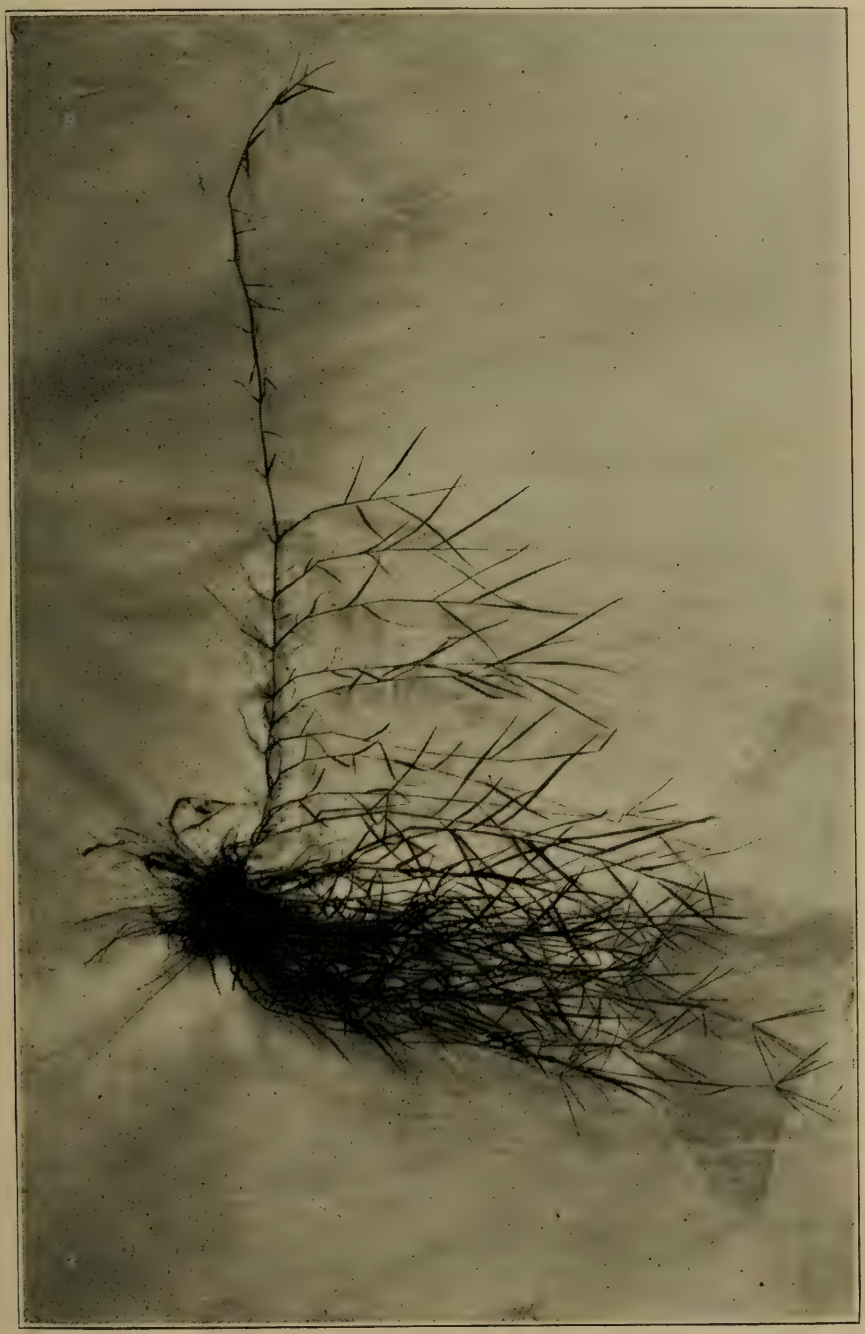
Eradicating Bermuda Grass.—There is no great difficulty in destroying Bermuda grass on most soils. Assuredly one needs to know its nature and go at it intelligently. It is best to combat it with shade. The land may be plowed in the fall and sown to wheat or oats. In order to have a rank growth of either of these grains, fertilize the land well. Harvest the crop, preferably for hay, before the Bermuda makes much growth in the spring, and at once plow thoroughly again. Here the worn, half-starved mule of the negro tenant farmer must be replaced by the well-fed span of the modern intelligent farmer. It requires motive power to do things right. Sow the land to cowpeas or velvet beans, choosing a very prolific variety that makes much vine. The peas

had better be cultivated and fertilized as well. When they are taken off the land will be free from Bermuda grass and in more fertile condition than ever before. When the peas come off it may be sown again to wheat, vetches, alfalfa or some suitable clover. The following spring it may safely be put to corn or cotton.

Choice of Land for Bermuda Grass.—I observe the best Bermuda growing on sandy loams or on the loess soils along the Mississippi River. On hard clays and "buckshot" lands it does not yield nearly so well, mainly because when tramped by stock these lands become so very hard that they dry out badly and the Bermuda suffers an almost continuous thirst.

Bermuda Grass in Oklahoma.—I have seen nothing finer than the Bermuda grass lawns and pastures of Oklahoma. John Fields, former director of the Oklahoma Experiment Station, was the first to see the great value of this grass for that state of hot sun and summer dryness, and his efforts have resulted in thousands of Bermuda pastures being planted there. L. A. Moorhouse in Bulletin 75 of the Oklahoma station writes thus of the history of Bermuda grass:

"Bermuda grass is a well-known plant in our southern states. It has been grown in the south for more than three-quarters of century, and many are, therefore, familiar with the characteristics of this plant. According to the most authentic records this grass was formerly introduced from the tropical regions of the east, and it is not indigenous to the Bermuda Islands as the name might lead us to suppose. One of the earliest records of the appearance of this plant in America dates back to 1825, at which time it was found growing in Georgia. It was distributed to some extent at this early date; thus this grass has come to be of economic importance



A Typical Bermuda Grass Plant.

in southern sections. Bermuda grass seed was sown in Oklahoma in 1892, and a set was secured in the Experiment Station grass garden. The frosts of winter damaged the stand to some extent; however, a subsequent analysis of the plot led to the selection of some plants which survived these low temperatures. These plants when reset came through the winter in good condition, and a new growth started quite early in the spring. Later studies with regard to this feature have demonstrated the fact that this selection possessed a characteristic which has been described as hardiness.

"In referring to the initial selections the following outline was made a matter of record in Oklahoma Bulletin No. 70, entitled 'Hardy Bermuda Grass': Close observation of several different plats of Bermuda grass indicated that some of it withstood the cold weather better than others and began growing as early as April 1, even after a hard winter. In order to test this characteristic more carefully a large planting of roots was made early in July, 1904. Part of the roots were taken from a plat recently grown from seed. Other roots were taken from a plat that had been growing for at least 10 years and which may have started from seed sown in 1892. Its source is not known, but it is certain that this grass passed through the freeze of February, 1899, when the temperature fell 17 degrees below zero with no snow on the ground. Little difference was shown in the growth of the grass from the different plats, and there was a heavy growth over all the field before frost. In the spring of 1905, after an unusually severe winter with a temperature of 18° below zero, there was a marked difference. On March 29 all of the Bermuda grown from acclimated roots was green and growing vigorously. It soon covered the ground perfectly to the exclusion of crab grass. When roots recently grown from seed were planted, all the previous season's growth was killed; new growth did not start from the roots until May, and then only in patches. There was more crab grass than Bermuda grass on this plat throughout the season.

"Bermuda grass roots have been sent out to a large number of districts within this state. Within the past 15 years a large number of the standard grasses have been grown on trial plots at the station farm, and it has, therefore, been possible to compare these types not only with Bermuda grass, but they have also been compared with our native pasture grasses. For the average upland soils of central Oklahoma Bermuda grass is superior to such types

as Kentucky bluegrass, English bluegrass or meadow fescue, and Bromus inermis or brome grass; after making these tests we are also firmly convinced that Bermuda grass has a wide range of profitable culture in the new state. In making field trials with the grasses which have been mentioned, it should be observed that some success might attend the efforts of the husbandman if these grasses were grown on very fertile soil, as the rich alluvial river and creek bottom lands of the state; but we must remark that such areas are ideal for the culture of alfalfa, and, wherever this forage plant can be grown, it should be given the preference. The common grasses do not return more than two cuttings per season at best, and the yield per acre would not exceed 2 or 2½ tons; alfalfa, on the other hand, makes at least five crops per season, and will bring all the way from 5 to 7 tons per acre on such land. The lesson which ought to be drawn from this discussion may be stated briefly: Use the best land on the farm for alfalfa; the poorer sections can be set aside for the growth of Bermuda grass.

"In rolling sections large ditches or gullies are frequently washed out by the roadsides, and if no attempt is made to check this erosion the road bed itself may be cut to such an extent that it will be impossible to haul heavy loads over that portion. Bermuda grass may be used to check such washes. It may also be planted on very rolling fields. We have many field illustrations in this section which serve to show that continuous culture, whether it be with corn or cotton, results in such a disfiguration of the surface that many portions are finally discarded. Areas of this character should be devoted to pasture, and if planted to Bermuda, the soil will remain intact. Bermuda grass furnishes an excellent covering for pond banks, and it may also be planted in districts where the sand has a tendency to drift or blow."

Preparation of Soil.—"Fields which are to be set to Bermuda grass should receive almost as careful preparation as in cases where the land is to be used for the production of corn or cotton. Although this grass is a persistent and vigorous grower and thrives fairly well, when planted on a poorly-prepared surface, it will respond readily to good treatment. It can be grown on all types or classes of soil, from the sandy or open type down to the heavy impervious clay soils. If the soil is open in structure and does not have a tendency to bake, the plowing may be done two or three weeks prior to planting; the heavier soils should be plowed early

in the season. A few severe frosts assist materially in securing a mellow surface or seed bed. A few days prior to planting the field can be worked down thoroughly with a disk harrow, and later, may be brought into level form with a smoothing harrow. In latitudes as far north as central Oklahoma Bermuda grass does not produce very much pasture after the middle of November, and the plants lie dormant during the winter months. The new growth starts as early as March 15, and if the spring is open, some pasture may be secured from the field during the latter part of April. Bermuda grass makes its best growth during the warm summer weather, and, for this reason, it is not advisable to plant roots much before the first of May. We prefer to do this work in May, at which time the soil is usually moist; hence the roots commence to grow and spread as soon as they are placed in the soil. We have already stated that it is not advisable to use seed. The planting season, then, opens about the first of May and the work may be continued throughout May and June. Fairly satisfactory sets have been obtained in cases where the roots were planted as late as July 15. The later plantings are not as desirable as the earlier plantings, for the reason that the dry summer weather checks the root in its growth, and a dense turf cannot be produced during the latter part of the season unless the weather is ideal."

Method of Planting.—"After the soil has been cultivated thoroughly it may be marked off in rows 30″ to 36″ apart and small pieces of Bermuda roots may be dropped at intervals of 18″ in the shallow furrows or rows. A corn-marker or a cultivator with two heavy shovels set at the proper distance may be used to open the furrows. The roots should be covered with a small quantity of earth. It is not a difficult matter to provide this covering either by using a hoe, or by moving the earth with the foot as the roots are dropped. If the seed bed is loose and will permit the rapid escape of soil moisture, this condition may be changed by using a roller on the field. Some growers make a practice of harrowing after the sods have been planted, but this operation has a tendency to bring many of the roots to the surface; hence they fail to grow. Others prefer to scatter the roots broadcast and disk them in; however, this method has not given as satisfactory results as the first plan. Bermuda plants produced from seed have in some cases made a fair showing the first season, but many lack vigor and severe frosts will destroy the major portion of them."

Carpet Grass (Paspalum compressum): a, attachment of spikelets to rachis; b and c, spikelets; d, floret.

Carpet Grass (The Paspalums).—There are several species of paspalum. They are low, creeping, spreading grasses that come in moist land in the South. They make the best grazing on the lowland prairies of Florida, and are often seen in Louisiana. Animals like to graze on carpet grass, but it is less nutritious than Bermuda, which it sometimes crowds out. I do not know that seed of these native carpet grasses is ever sold; it is sometimes spread by cutting the ripe stems and spreading them over the land. The carpet grasses are good pasture grasses and are mentioned here because probably southern readers may desire to know how good a thing they may have growing wild. Compared with Bermuda the paspalums are hardier, and are green in cold weather, though they do not actually grow unless there is some warmth in the soil. They are easily eradicated by land cultivation.

Texas Bluegrass (Poa arichnifera).—Perhaps this should have been described among the poas. It is left for this place because it is distinctively a southern grass. If only it had some way of easy distribution and seeding, it would be an invaluable grass for southern soils. It makes a very beautiful sward, which is green at nearly all seasons in the South. It is thus far better than Bermuda grass for a lawn. In Kansas, Prof. Shelton reports that it is hardy and that it yields three or four times as much as Kentucky bluegrass. The seed of Texas bluegrass is very light and peculiar, having a cobwebby feel. I have not been able to get a stand of grass by sowing the seed, though it has a way of thickening itself after the manner of poas when one gets a thin stand. It is

Texas Bluegrass (Poa arachnifera).

better spread by planting small bits of sod as one would potatoes, only covering no more than an inch deep. The sod may be cut into pieces no more than an inch square, so that a little of it will go a good way, but as it does not spread so very rapidly the bits should be placed about one foot apart. Texas bluegrass likes good soil. If I were living in the South I should endeavor to establish it in my garden, whence I could transplant it to the lawn, and later perhaps to permanent pasture.

St. Augustine Grass (Stenotaphrum dimideaton).—This grass is used in Florida as a lawn grass. It seems to thrive on very poor sandy soils, and to make an excellent sod. It seems hardy as far north as Charleston, but is not seen far from the coast. It is planted by cuttings, as is Bermuda grass.

Quack Grass (Agropyrum repens).—Death is a thing that is pretty sure to happen to the other fellow. No one ever considers that it may happen to him. The same thing is true of our enemy, quack grass. We see it on other men's farms, and complacently believe that it will never attack our own. It is in Iowa, Minnesota, New York; it will never come to Ohio or Illinois, so we imagine. Take it from me that quack grass can and will come to all regions north of the Ohio River, and I see no reason why it should not thrive far south of that. When it comes it comes unannounced. You do not dream that you have it till it has made a few patches in your field so tough that men can not cultivate through them; then you begin to wonder what it is that has possession of you. It takes you after that several years really to awaken to a

Quack Grass (Agropyrum—triticum—repens).

realization of what it means to root it out. After all, quack grass is one of the best of pasture grasses. If one cared only for pasturing a field he need not desire a better grass. It is like bluegrass in its habit of growth, only the running underground stems or rootstocks are longer, and penetrate deeper. One can turn up a sod of bluegrass and have every rootstock so that the whole mass is easily killed. This is not so easy with quack grass, as it roots too deeply for that. It is a good pasture grass for that very reason. It grows from 1′ to 3′ high and makes a dense mass of leaves and stems. The forage is sweet and good. It makes a lot of hay on good soil, but one should cut it before any seed stems form, else it will seed further areas by the seeds getting in the manure.

Quack grass is a pest in Europe. In England it gets into the alfalfa meadow and destroys it in a few years. It is harder there to destroy than here, because there the earth seldom becomes dry enough to kill roots not actually raked out into the air. In Iowa it has been said that the value of a farm infested with quack grass was cut in two. In Minnesota it is very troublesome. I once attended a number of farmers' institutes in Minnesota and it was amusing to observe that in our question box at every point were several questions alike, "How can I kill quack grass?"

On rich black soil if quack is left to thicken for a few years it is all but impossible to plow through a sod of it. It is impossible to cultivate through it with ordinary cultivators; they will not pass through the tough sod. It is well, therefore, to take it in time. It came to Woodland

Farm all unawares. We got the seed in some grass mixture, and before we knew it, it had become a pest. There had been brome grass in the field and we thought at first we were only having trouble with that. Later we learned with a good deal of alarm what had possession of us, and began to fight it rather vigorously. At the outset we plowed the field very thoroughly and with the harrow kept the grass down till corn could be planted. We began to cultivate the corn before it was up, and cultivated it deep and often. To our joy the grass proved under our Ohio sun easy to kill, once the roots were thrown up to its rays. Twice during the summer men went through the field with hoes and carefully dug out what the plows had missed. To get after the worst patches I had special tools made by taking 4-tined hay forks and having their tines bent at right angles like human fingers. These scratchers will dig down into a patch of quack grass and pull out every root. It is not enough to cut off the tops unless it is done more often than is practicable on the ordinary farm. One must dig out the roots. To our delight the enemy has been put to flight. At really very slight expense more than we should have taken to give the corn thorough tillage, we have the grass so subdued that it is rather hard to find. As I write men are searching carefully for stray plants of it. We will repeat this promising method next year and hope thus entirely to eradicate it.

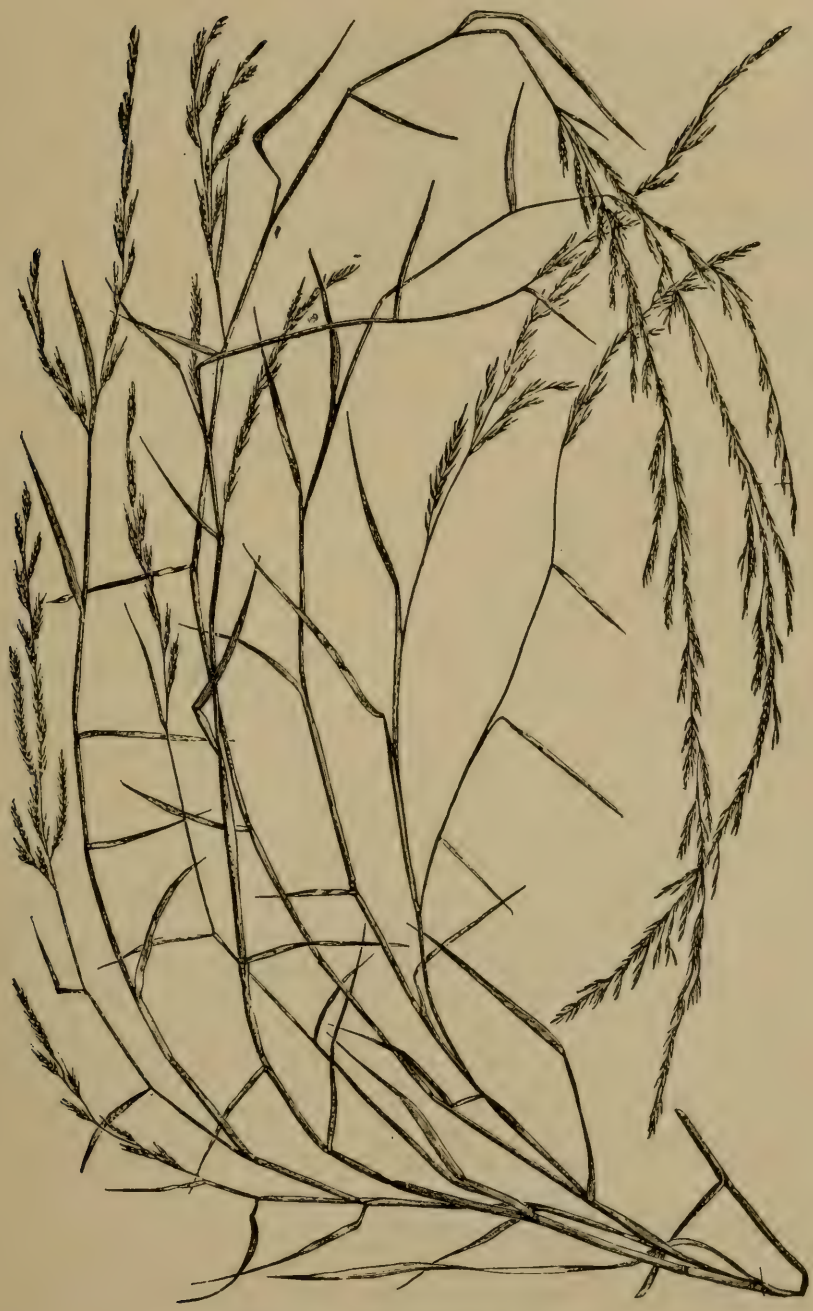
We are foolish if we let quack grass encroach on our cornbelt farms. It is sure to be a worse pest in the land where small grain is the chief reliance. It must have a

hoed crop—a crop that can have deep cultivation in order to subdue it.

First then, to know it, be on lookout for it. One can not trust to one's men for this; they are not sufficiently close observers. When you see a suspiciously persistent grass in your cultivated field go at once and dig to see what sort of root it has. The top of quack grass is not unlike timothy at first; the blades are narrower; when it heads the head is distinctly different but it will not head maybe for a year or two; do not wait to see that. Dig down and see if it has that running underground rootstock, about as large as a shoestring, with its sharp point, shooting out after new space to fill. If you find that get busy. Do not dread it, do not worry over it, but above all do not procrastinate a day; get action of some sort. Salt will not kill it unless enormous amounts are used. Dig it out; cut it off deep under the ground but as far as you can; get the roots out where they will dry. Then "do it now." Do not put it off; if you have only a few patches of the grass today you may have a solid field of it in a few years.

It has been said that there is no more valuable pasture grass for Nebraska and Dakota than this, and it may be true; it is assuredly a sweet, nutritious grass and rather heavy-yielding. I should sow brome grass though, for there is no doubt as to our ability to get rid of that when we wish.

Nimblewill.—This is often mistaken for quack grass. It is a branching grass, with a peculiar odor. It has sharp-jointed creeping rootstocks and also makes a bad



Nimblewill (Muhlenbergia Diffusa).

weed, but it does not send out so long underground runners and so spreads very much less. Moreover, one can with one pull of a hoe unearth every bit of a clump of it and shake off the earth so that it dies. I do not know the real value of nimblewill, but advise its extermination. Like quack grass it is very bad for alfalfa, and soon crowds it out.

Eradicating Quack in the Northwest.—For some reason the grass is harder to destroy and spreads more rapidly in northern regions than elsewhere. It may be because of our habit in the cornbelt of frequent rotations of corn which is cultivated during hot, dry weather when the grass is easiest killed, while the northern regions are more given over to crops of small grain. Prof. Henry L. Bolley of the North Dakota Experiment Station thus relates his method of destruction in *The Breeder's Gazette*:

"To give advice to farmers whose lands are now over-run by quack grass may seem as though adding insult to unavoidable injury, for to quack grass extermination there is no easy road. No spraying method for eradication of this grass is economically possible while other crops are to be grown. Direct application of salt to the areas has not proved satisfactory. If in small patches uproot it in dry hot weather and as far as possible, remove all underground stems. Visit the areas once every eight or 10 days and remove every apparent spear of grass with the attached underground stem. Or cut it off in July and cover closely with tar paper so as to quite exclude the light. Allow the paper to remain there through July and August; then plow deeply. Or cut it off closely in July and cover deeply with straw or manure. Visit the areas often. Dig up any scattering plants not covered.

"If in large areas, mow the grass off when in blossom, break the sod shallow (not to exceed two inches) in mid-July. Back-set in mid-August at a depth but slightly deeper than before. Then

disc and harrow throughout the fall never allowing any green leaves to show. Then plow deeply in the late fall. Plant a cultivated crop the following season and follow the cultivator with a hoeman who looks for every spear of the grass. Or, after thoroughly preparing the seed bed in the spring give it a heavy seeding of German millet, say, 2 to 2½ pecks of good seed, preferably sown broadcast. Sow the millet late in May. At no time during this process of field preparation should the quack grass be allowed to show green and if possible the ground should never be worked while wet. The drier the ground and hotter the weather the better the killing effect of the cultivation. Any annual forage crop which will give a dense and rapid growth may be substituted for millet though I think it has no equal unless it is fodder corn sown broadcast."

THE LEGUMES.

For a full and valuable account of the cultivated legumes I refer the reader to "Forage and Fiber Crops of America" by Hunt. Prof. Thos. Shaw also has an excellent book on clovers, and Prof. H. Garman of the Kentucky Experiment Station has an exceedingly valuable descriptive bulletin on legumes (No. 98). Within the limits of space assigned to this volume I can give only a very superficial account.

The leguminosae comprise a vast number of plants. Some are tiny herbs; some are among the largest trees. Among the common ones are the peas, beans, locust trees, clovers, alfalfa, cowpeas, soybeans and vetches. It is a curious thought that all these plants probably came from one stock; the ancestral form of the sweetpea, alfalfa, red clover, and locust trees is one and the same. If one will look closely one will indeed see that flowers of the pea, the bean, the locust tree and even of the clover or alfalfa plant are very much the same. There is no other

flower with a structure similar to that of the legumes. There is often a similarity in seed as well; the seeds are usually in pods of a peculiar and familiar shape—usually like little kidneys, though some are round, as the soybeans. If one tastes the seeds one is astonished to find them with a good deal of similarity of flavor. I have when a boy sowing clover seed caught seeds in my mouth and chewed them, marveling that they tasted so much like beans or peas. Nearly all the legumes have more or less showy flowers. Why is this? Be assured the brilliant coloring of the pea or the clover is not meant for your delectation. Things do not happen in nature. There is reason for all of nature's processes. In the case of the legumes it means that they can not pollinate their flowers unless they have the aid of insects. The insects find the flowers because they are showy. To reward the insects, or rather to induce them to come and do the work, there is usually found in the flower a sweet nectar, deliciously scented. Some blooms, such as alfalfa, are most ingeniously arranged so that as the insect crawls down the throat of the flower it touches a little trigger, the flower violently explodes and the pollen-bearing part is thrust vigorously upward to perform its work of fertilization. One can imitate the work of the bee in the alfalfa plant by scratching the throat of the opened flower with a pin point or end of a grass blade. All of this is most curious and seems in direct refutation of any idea that the world came into existence without a guiding intelligence. It seems probable that nature meant the legumes to be always cross-fertilized, though this point is as yet uncertain.

Acquiring of Nitrogen.—Leguminous plants have a high nitrogen content. In the farmer's parlance, they make "rich feed." They are rich in protein. Protein is the thing in feeds of which the world is most short. Legumes are rich in nitrogen, and nitrogen is commonly deficient in soils. Legumes make soils on which they grow rich, particularly when they decay on the land or are turned under. The farmer knew ages ago that clovers, alfalfa and other legumes enriched soils. Within very recent years men have learned how this is done. It seems to be accomplished by means of micro-organisms living on their rootlets or in nodules attached to their roots. There is much to learn about this process.

How the Nitrogen Is Secured.—There is much to be learned yet about how this work is done. So far as we now know this is the way of it: There are probably a number of kinds of bacteria inhabiting leguminous plants. Few if any legumes are without their own especial sort of bacteria, and each sort produces on its host plant a nodule or tubercle. One can find these even on locust trees, on wild legumes, on soybeans, cowpeas and clovers of all sorts. Some men believe that the bacteria inhabiting one species will in a little time adapt itself to another species, if that chances to be planted on the soil which it inhabits; that is, if alfalfa were sown on land filled with red clover-inhabiting bacteria within a few months the bacteria of red clover would learn to grow on alfalfa. My own observation would not at all support this view. True, certain bacteria live on a number of related species. For example, the same bacteria, so far as we know,

Roots of soy bean, showing nodules.

inhabit alfalfa, melilotus and the bur clovers. It seems necessary to have separate inoculation for cowpeas and soybeans, while sainfoin, which has nearly always been a failure in America, is probably a failure in most instances through lack of inoculation. Red clover, alsike clover and little white clover seem to take the same bacteria, while it is doubtful whether crimson clover can get along without its specific bacteria.

One can tell "how it is done" as easily as one can define the nature of electricity. What we can see is that the bacteria attack the rootlets which very graciously build out fleshy coverings for them, "nodules" or "tubercles." These nodules vary in size from that of a very small seed to the size of a pea or larger. The nodules are full of nitrogen and inhabited by millions of bacteria. These bacteria are continually reproducing, growing, dying, giving up their nitrogen to the soil and plants. The bacteria obtain their nitrogen from the air that enters all good, dry, pervious soils. When you stop to think of it, nearly all leguminous plants thrive best in dry soils that the air easily can enter.

How the bacteria get from one part of the soil to another, how natural inoculation takes place, we do not know. Probably it is done mainly by the washing of soils and perhaps sometimes by the wind. Sometimes the bacteria do not come until they are artificially introduced by man. In some neighborhoods the bacteria of alfalfa are found everywhere and no inoculating is needed; in other neighborhoods, alfalfa seeding is a failure unless the proper bacteria are introduced.

Methods of Inoculation.—The bacteria are readily enough grown in cultures, and these cultures may be sent in liquid form to the man sowing seed of new legumes on soil needing inoculation. The liquid culture is diluted with additional water and the seed wet and sown. This has usually been found effective. Dry cultures are not often successful. The drying of the organism seems usually to deprive it of its vitality. Soil may be taken from a field where the legume grew and developed tubercles. This soil may be scattered over the new field and at once harrowed in to prevent the bacteria drying and being killed by sunlight. This method has given better results thus far than any other. There are several ways of using this method of soil inoculation. If one is inoculating a field near another field that has already good inoculation one can take earth and spread it with the manure spreader. This is the best method where soil is in abundant supply. Follow the spreader close with some efficient harrow that will cover the soil from sunlight. It seems that either sunlight or drying will usually destroy the bacteria. It is well, then, when it can be done, to apply the soil after 4 o'clock in the afternoon and at once follow with the harrow, stirring it into the soil. Where soil is harder to secure one may sow a very small amount and yet get inoculation, if only it is well spread and carefully covered. Often in sowing alfalfa seed I have directed the use of 100 pounds of soil mixed with 20 pounds of seed, the two sown together. This has given good inoculation. Or, one may make one's soil fine by sifting, wet the seed and mix with it soon after wetting

just enough soil to make it so that it can be sowed again. This gives good inoculation. Or again, one may simply leach water through infected soil and apply the water to the seed. This method is said to have been successfully used at the New Jersey station.

Curiously enough, when stable manure has been applied liberally to soils, they are often found inoculated with bacteria belonging to certain clovers that may never have been grown there, and none of the substance of which had been applied to the manure. For example, alfalfa sown on manured land seldom needs any additional inoculation to cause it to be covered with nodules; whereas on land adjoining none could be seen. This has been frequently observed even when no alfalfa hay had ever been fed in the barn whence the manure came, and is a mystery yet to be cleared up.

Clovers Needing Inoculation.—Crimson clover seldom thrives except when inoculated, and inoculation is by no means common in the South until the clover has been grown for several years. The fact that it grows up so slenderly when not inoculated has caused many experimenters in the South to discard this very valuable winter-growing plant. I have observed in Tennessee that inoculated plants made more than 10 times the growth that non-inoculated plants made close by. If one wishes to grow crimson clover in a new region of the South one should inoculate at least a small area, whence later earth could be taken for inoculating larger areas. An acre will inoculate a county, the earth rightly used. A flower-bed of crimson clover in the garden may be the source of soil

for a needy field. Bur clovers need inoculation on many soils, especially those away from the limestone and river bottoms. Alfalfa quite generally needs inoculation in eastern and southern soils. For some unexplained reason alfalfa on alluvial land commonly needs no inoculation. This is true of the land along the Mississippi and Missouri Rivers. Whence came the bacteria there? It is a curious thought. Alfalfa needs no inoculation anywhere west of the Missouri River, so far as I have seen. Doubtless there are soils where it does not early find the right bacteria, but the other conditions are so favorable that it manages to get along till the bacteria arrives—whence, we do not know. In the East it would die awaiting its allies. Along the Pacific Coast in Oregon and Washington I think inoculation is often useful for alfalfa. This is the verdict of many growers in that region.

Vetches need inoculation on many, if not most, soils. Without inoculation the growth is very small and poor. With it there may easily be a hundred times the weight of plant that would be seen otherwise. If one sows vetches on land unused to them and gets only a few thrifty plants one should sow again the following year and maybe then one will find the inoculation good.

Soybeans need inoculation nearly everywhere. One can either secure earth which when powdered one can sift over and mix through the seed, or sow earth over the land as one would for alfalfa, mixing it in promptly. The second year of soybeans usually sees good inoculation, often when no artificial means have been used. Curiously enough the varieties vary in their ease of inoculation,

some vigorous sorts taking it much more rapidly than others of the more moderate-growing kinds.

All New Legumes May Need Inoculation.—I once tried to grow gorse plants in Ohio. Gorse is a common shrub in Europe, bearing a yellow, pea-shaped bloom. Though in good soil, still they refused to grow, probably because I had neglected to bring their peculiar bacteria with the seed. Whenever one is establishing clovers, cowpeas, soybeans or any new legumes, one is wise if he finds some source of infected soil to start the bacteria at work. The little white clover is the one thing spread by nature from northern Canada to the Gulf, which has always its bacteria with it. It is astonishing how much inoculation usually helps. I have growing in good garden soil, plants of Cassia occidentalis, a common leguminous plant of Louisiana, there called "coffee weed." It will grow there nearly 6 inches a day and has nodules as large as peas thickly studded on its roots. Here, on rich soil and during weather as hot as Louisiana often sees, the growth without nodules is no more than 2 inches in a week.

Conditions Favoring Bacteria.—Good agriculture is essentially practice that favors helpful bacteria. When conditions are right for them they are steadily gathering nitrogen from the air, adding it to the soil, and it is then taken up by plants. Experiment has shown that there may be gathered by the legumes very great amounts of atmospheric nitrogen, as much in one year as would cost, were one to buy it, $30 or more, on one acre. Thus, when legumes thrive, when the soil conditions are right for them and the bacteria are abundant and active, one

may see the soil become richer and richer year by year. Even when the legumes are each year removed from the land the soil may accumulate nitrogen. Hunt gives an instance of a soil area at Lupitz which bore 28 successive crops of lupines which were removed and nothing supplied but kainit. Notwithstanding the large amount of nitrogen removed from the field it was found to make a steady gain in soil nitrogen. The conditions that favor the useful bacteria are that the land shall be moist but not wet, shall have air entering it somewhat freely, and shall be alkaline, not acid, in its reaction. The presence of a considerable amount of carbonate of lime in the soil is very favorable to these nitrifying bacteria. It is clear that they can do nothing in a waterlogged soil, since it has in it no air. It has been abundantly proved that sour soils are unfriendly to legumes and unfriendly to their allies, the bacteria. Indeed it may be true that the one reason why sour soils are unfriendly to legumes is that the bacteria will not increase there.

Carbonate of Lime and Legume Growing.—It is very noticeable that in regions with much carbonate of lime in the soil wild legumes are abundant. In the semi-arid regions, where soils are usually rich in lime—because it has never been leached away, one often finds a great number of species of legumes. Such soils are so well filled with many kinds of bacteria that few legumes growing on them need inoculation in order to start out vigorously as soon as sown. In other soils, where lime is wanted, one finds few or no legumes at all. I was recently engaged in studying certain mountain soils in California and dur-

ing several days' riding I saw hardly any leguminous plants. Analysis of that soil showed me what I expected to find, that it was most markedly deficient in carbonate of lime. At the same time it is so markedly unproductive that no successful efforts have been made to grow on it grain or gardens without manures. On other soils in similar location and altitudes where much carbonate of lime was found in the soil, the number of wild peas, vetches, lupines and other leguminous plants was astonishing, and when that soil was plowed its fertility was found to be very great. It is the truest thing in nature that legumes make soil rich and carbonate of lime makes legumes grow thriftily. This lesson has long been understood in the Old World. There since the history of agriculture was first written lime has been used as a soil-corrective to make it produce legumes so that it may gather riches and feed man. Indeed, the fathers did better than the sons are doing today, for the increased use of commercial fertilizers has to some extent displaced lime, and the result has in many instances been evil. I have seen land in Scotland reclaimed from barren heaths in the following manner: First, deep drains to lead away the surplus moisture, then the use of "20 cartloads of lime" to the acre (unburned marl or chalk, I think, was used), afterward good plowing, then a moderate amount of manure, and seeding to grasses and clovers. Thus were meadows established where nothing but wild heaths had grown before, and on these meadows sheep were fed, phosphorus sprinkled from time to time with manure, till at last a very rich, productive soil was gained, almost

unbelievable in its contrast to the barren, heath-covered soil only across the wall.

Most plants crave nitrogen; men work for it; women and children starve and die for it by thousands every year, while nitrogen exists in unstable compounds, and if we do not use care it is soon gone from us. Infertile soils are nearly always nitrogen-hungry. With enough nitrogen in our soils we could easily support two blades of grass where one grows now, with all that that implies in added comfort for greater numbers of men and women in the world.

Air and Our Nitrogen Supply.—There are few spots on the world where nitrogen is found in such combinations that it can be mined and used. Over each acre of soil there exists about 75 million pounds of atmospheric nitrogen. The one way that we can get it changed into form that we can use is by means of the bacteria in the soil. True, the electrician with command of tremendous electric power, can secure nitrogen compounds that the farmer may use, and this is being done in a small way in Norway and elsewhere, but the farmer may have on his own place a complete establishment for nitrogen-gathering that will work silently and surely, day and night during the growing season. In order to have this, however, he must first store in his soil a supply of carbonate of lime. It is true, then, that adding carbonate of lime to a lime hungry soil, and then planting it to legumes, is as though one added nitrate of soda to the land. Nitrate of soda will do wonders in making crops grow, but it is costly to buy. When one grows clovers, cowpeas, vetches,

alfalfa, or any other nitrogen-gathering legume accompanied by its particular form of bacteria, in a soil favoring the bacterial life on the legumes, one is indeed increasing one's nitrogen store very fast.

The amount of nitrogen gathered will vary according to the sort of plant grown, and then according as the soil is fitted to make large growth of legumes. That is, in order to help plants in their work of nitrogen gathering, one should make the conditions as favorable as possible in all things except supplying nitrogen. The plant that comes to a soil rich in carbonate of lime, rich in phosphorus and potassium, with air enough in it and moisture enough, will gather a great deal more nitrogen than one growing in a soil where any of these factors are lacking. So if one wishes to enrich soil by growing on it cowpeas, clover, or any legume, one should begin by making it dry, by plowing well, and then supplying what phosphorus may be needed. Thus strengthened, the plants will gather very much more nitrogen than if they struggled to grow in a soil inhospitable because waterlogged, hard or poor in phosphorus or possibly in potassium.

Dr. Cyril G. Hopkins, experimenting with alfalfa (one of the most energetic gatherers of nitrogen) tested plots with inoculation against plots without, assuming that the uninoculated plots got all their nitrogen from the soil. He found that alfalfa, when supplied with lime and phosphorus, gathered about 252 pounds of nitrogen per acre, worth 15 cents a pound, or $37.80. In contrast a plot having no inoculation, and neither lime nor

phosphorus applied, made about one-third the total yield, and, unless bacteria found their way in unaided by man, gathered none of its nitrogen from the air. The plain fact is that one can afford well to make the conditions so that the bacteria will gather nitrogen. Indeed one can not afford to farm in any other manner.

Humus Aids Nitrifying Bacteria.—It is noticeable that where there is much vegetable matter added to the soil, legumes thrive especially well, and by aid of their bacteria gather especially large amounts of nitrogen. Some legumes seem more dependent on the aid of humus than other. Cowpeas, for example, will grow where there is a rather small amount of vegetable matter in the soil, while red clover enjoys a plentiful supply. The lesson is clear. If you would build soils by aid of legumes do all that you can first to help them. Make the soil alkaline rather than acid by adding to it carbonate of lime, feed it with phosphorus, give it what humus you can, and see that it is supplied with the right sort of bacteria. Nature may attend to this duty, but, in case she has forgotten, do your part. Of all the steps needed to make legumes grow and thrive one can afford to neglect not one.

The Purpose of Legumes.—There seems in nature an orderly arrangement of things dependent on one another. For example, legumes store the earth with nitrogen. Grasses feed freely on nitrogen and grow rank when so fed. Thus, after clovers have made the land rich, grasses come with riotous strength and perchance crowd out the clovers. Afterward, when the grasses have depleted the soil of nitrogen, the clovers find foothold again. This is

nature's rotation of crops. The legumes exist, their bacteria store the priceless nitrogen, the earth is enriched thereby, and all manner of pleasant grains and grasses and fruits follow, feeding on this store of nitrogen gathered mainly by the legumes and their allies, the bacteria.

Other Nitrogen-Gathering Bacteria.—There seem other bacteria, not inhabiting legumes, that can in some manner store nitrogen. These are found in soils fairly well filled with vegetable matter. In old pasture sods are found the azotobacter bacteria, most beneficent organisms, storing fertility as they live on decaying leaves, roots and stems. There seem no helpful bacteria in any soils devoid of humus or legumes.

Lessons that All May Read.—See that field of oats with the sharply-outlined line of dark, rich green? On the part growing so rankly stood alfalfa or clover. The chances are there is now too much nitrogen there for the oats, and they will likely lodge. Corn should have been planted instead; it stands stiff no matter how big it grows and no soils are too rich for it. In California on alfalfa fields, orchards and orange groves have shown the effect of having been planted on alfalfa fields years after the alfalfa roots had crumbled to mould.

Value of Legumes.—Chemical analysis shows leguminous plants to be rich in protein. Protein makes red flesh, blood, milk and brain tissue. Most feed-stuffs are poor in protein; legumes come in to balance the excess of carbohydrates in the grasses and grains. Thus timothy hay is too poor in bone and muscle-making material, properly to nourish animals; a portion of clover or alfalfa mixed

through it makes it a more nearly perfect feed. In America our most common grain, corn, has in it too much starch and not enough protein for feed. If one has then at hand clover or alfalfa hay one can make a proper balance in rations for stock. Animals are quite largely what they are fed on. Thus ponies come from poor, barren, sour soils having no legumes and only poor grasses; splendid horses come from pastures rich in carbonate of lime and growing mixtures of grasses and clovers of several species. The horses raised on alfalfa meadows in California are among the most perfectly developed in the world; the horses of bluegrass Kentucky eat a fine mixture of bluegrass and white and red clover.

Legumes and Grasses Go Together.—While it is true that grasses alone are commonly deficient in that essential builder, protein, yet it is also true that the legumes are commonly too rich in protein and an excess of even a good thing may be nearly as harmful as a deficiency. Thus animals bloat on alfalfa pasture and horses fed exclusively and heavily on alfalfa hay may become "soft," that is, not enduring, through fatigue caused by an excess of the very thing in their blood that would build if fed only in right amount. So it is true that animals grazing clovers or alfalfa are ravenously hungry for grass and if allowed access to it or if grass is grown mixed with the clover or alfalfa they will not often bloat. Likewise animals pastured on grass are ravenous for clover or alfalfa, nature seeming to teach them what should be their diet properly to nourish the whole animal. Diversification is good for soils as variety for stock.

Effect of Legumes on the Soil.—I have never seen a legume that did not leave land better than it found it. Clovers penetrate deep with their roots and decaying leave channels for both air and moisture. Alfalfa is even more vigorous in such work. Vetches leave the soil loose and permeable. There is indeed a curious effect on the soil of the growing of legumes difficult to explain—the effect in making clays friable and hard soils mellow. The effect on the succeeding crop is indeed marvelous, especially if the whole forage of the legume is turned under or fed off on the land by animals.

Legumes May Not Enrich Soils.—Mooers has shown at the Tennessee Experiment Station that cowpeas grown in rotation with wheat, the peas cut and carried away from the land, apparently reduced fertility instead of increasing it. Probably the peas drew heavily on the soil's store of phosphorus or else drew so heavily on the moisture of the soil that the wheat following it secured a poor start in the fall. Assuredly if the mineral requirements of a soil are not given attention the taking away of crops of legumes may end in a depleted and unproductive soil.

THE CLOVERS.

The very sound of the word "clover" suggests fields of sweet-smelling bloom, bees, birds and sunshine. Take away the first letter and you have left "lover," the best estate ever achieved by man, and decapitate the word again and you have left "love," the mainspring of action in all that is best in the world. There are many species and varieties of clover. Curious readers should read the

chapter on varieties in Hunt's "Forage and Fiber Crops" where 30 species are listed and we are assured that 250 species exist. Since that book was written several new ones have been introduced from the Old World. We have not time here even to list them, but must content ourselves with describing those that are most commonly seen. One may know the clovers by their having leaflets in threes and each one attached at the main point, whereas in alfalfa and other plants belonging to the family of Medicagos the leaflets are differently arranged, with the two leaflets set down the mid stem a little way.

White Clover or Dutch Clover.—I sit to write this beneath an oak tree on the lawn and all about me is the green carpet of Kentucky bluegrass and little white clover (*Trifolium repens*). I choose this little clover to head the list because it seems the most universally found of any of the clovers. I have seen it in every land that I have ever visited except in the burning deserts, and even there it comes soon after man has begun to pour cooling streams of water over the thirsty soil. White clover seed is very small and easily carried; it is probably not digested when eaten by animals and thus the animals themselves in their journeying have taken it about. While white clover is found nearly over all America, yet I think it must be an introduced species since had it been truly native to America it should have been found on the prairies when white men first saw them, and there is no record of this.

White clover is a creeping plant, seldom rising more than 1′ high, but making a dense mat of herbage over the ground. The stems lying on the earth root freely after

the manner of strawberry runners and thus it rapidly covers the land when there is space for it and conditions are good. The flower stems may rise up 12″ or more and sometimes are so thick as to make the field one mass of bloom. There is a large species of white clover from Italy, called giant broad-leaved white clover. It is said to produce twice the herbage of the common sort, but to make few seeds. White clover likes rich soil and abund-

White Clover May 12 in Tennessee.

ant lime in it. It thrives in moist soil and during cool weather. In the north it is green all summer; in the south it nearly disappears during hot weather and reappears in the fall, remaining green and beautiful all winter. Thus it grows well with Bermuda grass. The amount of white clover in the pasture is a fair indication of its fertility of soil. One can bring it in by liming and dressing the land with phosphorus. Wood ashes, too, have a great

effect in bringing in white clover. In Maryland on very poor sands I have seen strips of white clover along the shell roads where the wheels had powdered the shells into dust and it had washed into the soil. Bees love white clover, as also do pigs, fowls and all grazing animals. It is richer than the larger-growing clovers and makes during the season a large amount of grazing. It is not of much value for mowing. The one objection to white clover is that after seed forms it sometimes causes horses to drip a large amount of saliva or "slobber." They should for a short time be taken off white clover pasture. It seldom bloats cattle or sheep, as other clovers do, perhaps because it is nearly always intermixed with grasses. I should add white clover to nearly every pasture mixture. Men often ask, "Why sow white clover—it comes of itself?" The truth is it comes much more abundantly and sooner, as a rule, when a little seed is sown.

Quantity of Seed to Sow.—The seed is small and 2 pounds will go well over an acre, so the expense of sowing is slight. It seems to be easily established, sown either very early in spring or, in the South, in fall. The seed may lie dormant for years if buried too deeply in the soil, growing after being raised near enough to the surface so that it can reach daylight—an example of the wonderful intelligence of nature.

Red Clover (*Trifolium pratense*).—This is the most common sort of cultivated clover in America, and the one of which most has been said and written. There are two species, the common red and mammoth (*Trifolium pratense perenne*). There seems all sorts of intermediate

forms between these. If the man exists who can surely know mammoth clover from plants of red clover I wish introduction to him. In a seedling nursery of several thousand clover plants at the Tennessee Experiment Sta-

Common Red Clover.

tion Prof. Mooers and I tried vainly to arrive at any conclusions as to characteristic shape of leaf or habit of growth that would distinguish the species. The plain truth is that red clover is extremely variable in habit of growth and character, and one could with little difficulty

select and propagate a hundred varieties of it. Many of these varieties would be superior, too, to the common assortment that one gets in commercial seed. Plants will be found having a weak stem, lying almost as prone on the earth as white clover; others that stand erect; some very leafy; some with leaves of one shape and some with another sort. Time of blooming and color and shape of bloom vary also and, unfortunately, some of the best varieties are poor seed producers. There is also a white-blooming variety; it is strange that some one does not propagate it, as it seems to be fully as desirable in manner of growth as the red. In my opinion there are not really two species of red clover, common and mammoth, the so-called "mammoth" being a later-blooming form of the common red, and a larger-growing variety.

Red clover is commonly classed as a biennial, living two years, ripening seed the second year and dying. It is very loosely and irregularly a biennial. Sometimes plants will ripen seed the year they are sown, and sometimes the conditions will be such that a field will mostly bloom and seed the first year. Many of the plants will then die, as seed-bearing is the function for which clover lives; others will live another year in weakened condition. Most often clover blooms but little the first year, but heavily the second year, forming seed and most of the plants dying. Always a few plants will survive for three or more years, but after bearing seed they do not seem very vigorous or useful. It is safe then to call red clover a biennial.

Habit of Growth of Red Clover.—Red clover sends down a strong tap root, sometimes to a distance of several

feet into the earth, and, branching, fills the upper soil pretty full of fibrous roots. The roots are well covered with nodules inhabited by nitrogen-securing bacteria. Most of the roots of this clover are found in the upper layers of soil. The top branches and many stems are sent from one root; vigorous plants in favoring soil may send up as many as 40 or more stems. If the soil and season favor, red clover makes a very dense mat over the earth, quite effectually smothering out weeds and perhaps favoring the accumulation of nitrogen by its very shade.

The nodules on red clover roots are much more easily found than on alfalfa and some other legumes, since they are more firmly attached and on larger roots. There are now few soils that are not inoculated with red clover bacteria, though once on prairie lands of Illinois, Iowa and other western states red clover repeatedly failed till finally by natural causes inoculation came. Red clover is grown everywhere throughout eastern America and westward till it meets alfalfa in middle Kansas and Nebraska. It is found in use along the seacoast in northern California and the states above. It is a lover of temperate climes, and in the South, while it will grow and yield fairly well, it is inferior to crimson clover as a winter-growing plant, and to alfalfa in summer. There are regions where red clover is supplanted by alsike clover. There are two causes that may make alsike clover more vigorous: one is a lack of carbonate of lime in the soil and the other the bacterial disease of red clover found in Tennessee and parts of Kentucky. The systematic rotation of crops corrects many soil troubles.

The Soil That Red Clover Likes.—One can form a good idea of soil by the way red clover thrives on it. If the clover is small, slender, easily displaced by weeds and grasses, the soil needs something. Perhaps the need is carbonate of lime; in fact, 10 chances to one it needs that since lime soils will grow healthy, vigorous clover even if it is small. Maybe the land needs draining or needs phosphorus, less often potassium or vegetable matter. Any one of these lacks may be fatal to good clover growth. A soil well underdrained, strongly calcareous, and with enough phosphorus and a dash of vegetable matter thrown in, produces red clover in splendid vigor. Wood ashes make red clover grow. On many areas that now produce it only sparingly, applications of lime make conditions right and it succeeds well. It is the basal truth that legumes love lime because alkaline earths favor their nourishing bacteria.

Seed and Seeding.—Red clover seed is commonly fairly free from adulterants, especially when one selects a seedman with some care. True, there are innumerable weed seeds found in poorly cleaned red clover seed, but most of these can be cleaned out by use of proper machinery. The various sorts of plantain are the most common weed seeds found, and they make very bad pests in new cloverfields. Clover dodder is found sometimes and is a deadly weed. A farmer who would cut for seed a field infested with dodder must have something wrong with his moral faculties. Occasionally clover seed is intentionally adulterated by seedsmen. Among the things put in have been alfalfa and the little trefoils. Alfalfa

seed is usually dearer than red clover seed, so there is not often danger of its use in this way and one could not desire a more harmless substitute if such one must have. Commonly red clover is sown in rotation after wheat. The usual plan is to sow timothy in the fall, following with red clover in March, February or April. Probably 99 per cent of the red clover sown in America is sown broadcast in the spring over fields of wheat, with no other effort than scattering the seed.

Quantity of Seed to Sow.—Usually 10 pounds of seed are sown on an acre. When conditions are right this plan succeeds well. If the frost loosens the soil or the rain beats down and covers the seed, if the soil is fertile and well drained, inoculated with the right bacteria and with enough lime in it, if the wheat and timothy are not too rank-growing, a stand of clover will be secured. In my boyhood days we secured wonderful growths of clover, but then our lands were newer and richer, with more phosphorus and humus in them. Today there is greater difficulty in getting stands of clover in this easy, hap-hazard manner. A better plan is to wait till the ground is dry enough to harrow, say in late March or early April, depending on latitude and climatic conditions; then harrow the wheat lightly and sow the seed. After the harrow has roughened the surface the seed will be covered usually by the first shower, though it may be harrowed again with good effect after sowing the seed. This harrowing will not often harm the wheat and may do it much good. Sown thus, one seldom fails in getting a stand of clover. Another plan is to sow twice, the first

time early, the second time late, using half the seed at each sowing. Five pounds of seed will give enough plants for an acre if only half of them grow. Some very good farmers follow this practice.

Sowing Clover with a Spring Crop.—I can get a better stand of clover by sowing it with a spring-sown crop. In this manner of sowing I can have the land better prepared, deeper stirred and less apt to suffer from summer drouth. One can sow with oats, barley, or flax. Spring barley makes a good mother-crop for red clover. One should choose a sort that is short and stiff in straw, so that it may not lodge. The beardless varieties have proved good nurse-crops for clover. Similarly with oats one should choose a short-strawed, strong-growing variety that is not apt to lodge. Thin seeding of the nurse-crop is best. I find a bushel of barley to the acre is enough, and three pecks of oats may prove too much if the soil is rich. To sow liberally of phosphatic fertilizer with the clover will stimulate it to strong growth and make it a better stand. One dares not put too much nitrogenous manure or fertilizer on the land, else one's oats or barley will be too rank in growth and apt to lodge; also bad weeds will spring up and choke the clover. Should one desire desperately to get a stand of clover, cut off the nurse-crop for hay when it is coming into bloom, or before it lodges. Thus taken away, it relieves the young growth which now comes rapidly forward. I have taken off a crop of oat hay and later in the summer a very fair crop of clover hay from the same sowing. Commonly splendid stands are secured in this manner.

Clover may also be sown alone in spring with first-rate success. I do not think the advantage quite sufficient to compensate for the loss of the hay or grain crop that might have come from wheat, oats or barley as a nurse-crop. Clover may be sown in fall on land especially prepared, usually with good results. Here much depends on the nature of the seedbed, which should be fine, firm and as moist as one can get it at that time of year. In plowing land for fall-seeding of clover one should harrow each half day what was plowed immediately before, making it at once into a fine, mellow seedbed. If one lets it lose its moisture after plowing one will hardly get a seedbed in time for fall-sowing. The time of fall-sowing depends on the latitude; in Ohio it should be in late July or August; in Louisiana it may be in October or November. Sometimes it is possible to get a catch of red clover by sowing in standing corn at the time of last cultivation. In parts of Minnesota and elsewhere this is practiced.

The common use of red clover in America is to sow it with timothy in wheat. The first year after sowing there will seem to be little timothy and much clover. The following year the clover is nearly gone and timothy prevails. Afterward the clover shows but little. I have tried to keep stands of clover more than two years by preventing its seeding, but have had rather poor success. I have tried also patching up thin clover meadows by sowing more seed, and this too has not usually resulted well, the new seedlings not growing off as they should. The best results seem to come from plowing red clover after

the second year and putting the land to some crop that will utilize the fertility that it has stored. Corn or potato seems the best crop for this place.

Sowing Clover Mixtures.—I have found that mixtures of clovers result in heavier growths and better forage than red clover alone. This is especially true when the clover is to be pastured. A mixture of red, mammoth and alsike clovers with a dash of little white clover and a goodly sprinkling of alfalfa has with us resulted in astonishingly good pasturage throughout the season. With this can be sown timothy if it is for subsequent mowing, though it is not of much use if it is to stand for but one season. However, the seed is cheap and it will at least repay that much.

Mammoth Clover.—This was until recently called *Trifolium medium,* now *Trifolium perenne.* It seems rather a distinct variety, maturing later, being of coarser growth and lasting longer in the ground. While I accept it is a distinct variety, yet the common beliefs concerning it are mistaken. It has been held that mammoth clover was worthless for hay; that it would not grow after being cut, so that two cuttings could not be taken off in one year, and that it had little or no value for pasture. The clover, as I have observed it, is simply a later-blooming, later-maturing variety of common red clover, and there are all sorts of intermediates between, perhaps caused by cross-fertilization of the blossoms by insects. Mammoth clover makes good hay if cut soon enough, though it is coarser in stem than the common clover; if cut early it will make a second growth the same year, and it makes good grazing for stock. For poor soils mammoth clover is doubt-

less better than common red; as a soil-improver it has some advantage, and to add to pasture mixtures it is probably better. One sows mammoth clover exactly as one does common red clover and the seed can not be distinguished. Seedsmen find considerable difficulty in getting the seeds of these clovers pure and true to name, and this difficulty arises in no small measure from the habit of the farmer in failing oftentimes to designate whether the seed he is offering is of the mammoth or common variety.

Making Clover Hay.—Volumes have been written about making clover hay. To make the best hay, clover should be mown before the blooms have turned brown and cured as much as possible without too long exposure to the bright sun. It should be raked before the leaves are crisp enough to powder and fall off, put up in small cocks not wide at the base and as high as they can be safely piled, left in cocks for a day or two to cure somewhat, perhaps afterward opened to the sun for an hour or more and then hurried to the mow. The test of right curing is when one can not by hand-twisting of a wisp of the hay cause any moisture to exude. There are, however, a thousand contingencies of weather that will interfere with any well-devised programme of clover haymaking in the land of summer showers. One must be a schemer, ready to take advantage of sun and wind, prompt to act when sudden dark and portentous clouds roll up in the west, patient and unstinting in cocking, opening out to dry, and cocking again. The alternative is to let the heads brown before cutting, mow in the morning of a hot, dry day and take to the barn in the

afternoon, using the hay-loader and side-delivery rake. Thus with the least cost and effort one gets a large amount of woody and less nutritious hay.

Growing Clover Seed.—Clover should be cut for seed as soon as the most of the heads have turned brown, and left to lie in the sun for a week or more before it is threshed. There are clover bunchers that attach to the mower cutter-bar that will gather the clover as fast as it is cut, or a self-rake reaper may be used. The less the clover is handled the better, since the heads readily break off. If rain comes it will do no harm; in truth, several rains with alternate spells of dry weather will make the clover hull all the easier. I have stacked clover seed with fair success, but it must stay in stack a long time and be well protected from the weather, else it will be too tough to thresh well. Ordinarily it is better to thresh from the field or else wait till a cold day in winter, when it may be threshed from the dry stack. Yields of clover seed vary from a few quarts to 10 bushels from an acre. A moderately thin stand, on a soil not too rich, makes the most seed.

Clover Dodder.—Within recent years a new pest has come to cloverfields—the slender parasitic vine, called dodder. It is an almost leafless yellow vine found twining itself about the clover stems which it ties into an inextricable tangle. Wherever it touches a clover stem it sends a rootlet into it and preys on the juices of the unfortunate host plant. In time it destroys the clover. It spreads rapidly. Dodder comes from seed and is at first attached to the earth. As soon as it reaches a clover plant

Field Dodder on Red Clover; a, Flowering cluster; b, cluster of dry seed vessels. From a photograph. Natural size.

it twines about it and sending in rootlets into it never afterward depends on the soil for sustenance.

Dodder can not all be cleaned from clover seed by use of the best machinery. If one finds it in one's field one should at once cut off the infected spots, and leaving the plants lie on the earth let them dry a few days, then add straw to them and burn over the spot where the dodder grew. In this manner one may easily eradicate the pest and prevent one's soil becoming infested with dodder seed. It seems little less than criminal to cut clover seed from a dodder-infested field, yet evidently some farmers do or we should not so often find it in clover seed. Laws insuring the purity of agricultural seeds have been put on the statute books in several states.

Clover and Timothy for Feeding.—Hunt says: "The total amount of digestible nutrients in 100 pounds of clover hay is almost identical with that of 100 pounds of timothy hay. The Pennsylvania station has shown that the full value,—i. e., the total energy that can be set free in the body of a steer, is nearly the same in both kinds of hay. The net available energy, however, of clover hay when fed to a steer as a maintenance ration is found to be considerably less than that of timothy hay. On the other hand, clover hay furnishes more than three times as large a proportion of proteids as does timothy hay. The practical application of these experiments would seem to be that, for the purpose of balancing the ration, clover hay has a high feeding value for growing or milking ruminants; but where the ration has already sufficient protein for the needs of the animal, clover hay

is not superior, and is perhaps inferior to timothy hay in feeding value."

SUMMARY OF RED CLOVER.

Red clover has done more than any other legume to benefit American agriculture. It is best adapted to the needs of the American farmer because it is so quickly and easily established, and commonly so hardy and thrifty. It is adapted to all of Canada, and the United States north of the Gulf States and east of the Missouri River. If one finds one's soil responding better to alsike one should try the effect of drainage and good liming, preferably with carbonate of lime (ground limestone), which will in most instances make red clover succeed, especially if one has added phosphorus and vegetable matter to the soil. Red clover is a better plant than alsike clover because it is larger-growing and deeper-rooted and more abundantly supplied with nitrogen-securing bacteria. It is not so good a plant as alfalfa where alfalfa may be grown, because alfalfa gives more and better forage and also enriches the soil more rapidly than does red clover. There are degrees in good farming. Alsike clover-growing might be called the first degree, red clover comes with the second degree and alfalfa with the third and highest degree. It is nearly true that any soil that will grow red clover will also grow alfalfa, if it is made a little drier by tiles, a little richer in carbonate of lime and phosphorus and given a little more humus. While one is learning to do the best thing one should keep one's red clover and strive to make it as strong as possible.

Diseases of Red Clover.—"Clover-sick" lands in Europe are found sometimes to be afflicted with a fungus which, attacking the clover, is sufficient to destroy it. I have not known of the presence of this disease in America. Clover-sick lands in America are commonly deficient only in lime, phosphorus and vegetable matter, or else are poorly drained, though I have known lands to refuse to grow the plant till potassium had been applied. Thorne found at the Ohio Experiment Station that liming cured soils that would not grow red clover. In Tennessee is found anthracnose attacking red clover and alfalfa, but doing no damage to alsike clover. Anthracnose is a fungus attacking stems and leaves and causing "clover-wilt." Diligent search revealed growing in the state many immune plants which were collected in nursery and propagated at the Tennessee station, from which it is hoped enough seed may be secured to restore the clover-fields of the state. In the meantime, alsike clover is being sown as a substitute for the familiar red, in which use it is fairly successful.

Alsike Clover (*Trifolium hybridum*).—Alsike clover has a curious resemblance to both red and little white clovers, and is sometimes called a hybrid, though there is no proof that it is so. It has in part the recumbent habit of growth of little white clover, but is much larger and makes more hay. It is a smaller-growing species than red clover and yet it will in certain soils make more hay. It is able to endure wetter soils than red clover, and is not so hungry for lime. Thus it finds certain ranges of soil and situations on which it is a better clover than any

other. In Europe it is esteemed a perennial. In our own North and East it is said to be nearly a perennial. In Ohio and southward it is, however, much shorter-lived. I do not think it worth planting where red clover or alfalfa thrives, except in mixtures where it seems to add to the weight and quality of the hay. Alsike clover feeds bees, which red clover does not usually, and it makes delicious honey. It makes a good seed crop, and the seed is so small that one may sow less than half the amount that one would sow of red clover. The seed is in the first crop, though it may be pastured for a time in spring. It is better to sow alsike clover with timothy, as it is then less apt to go down and be hard to mow. A good mixture is timothy 15 pounds, red clover 6, and alsike clover 4 pounds when cut for hay. A favorite mixture, and one in general practice in middle Tennessee, is 5 pounds orchard grass, 5 pounds meadow oatgrass, 4 pounds redtop, and 4 pounds alsike.

Alsike clover has come into disrepute in certain sections because horses and mules pastured on it exclusively have been troubled by eruptions of the skin. Unless the vital organs are affected, animals recover all right on being removed from such pasture. This has affected more animals which have white feet or noses. The cause of this malady is obscure, and so far as observed no cases have originated in pastures having grasses mixed with clover. I have not heard of animals being affected by eating the hay; the disease originates in pastures.

Crimson Clover (*Trifolium incarnatum*).—This clover is often called scarlet clover or carnation clover, and in

England trifolium. There are two varieties: one with crimson and the other with white flowers. There are in France recognized a number of minor varieties differing chiefly in their time of maturing. A field of crimson clover in bloom is a sight not soon to be forgotten. The bloom is more brilliant than that of any other plant of our fields or meadows. The clover is well worth growing as an ornamental in the flower bed if there is not room for it in the meadow. I recall vividly the crimson patches on the landscapes of England and France, more especially the latter. In France it seems the custom to sow clovers in mixtures. I have seen crimson clover sown with red clover and rye grass, all mown off together and fed to dairy cows. In England it is used as a soiling crop for lambs that are fitted for the shows, and it is a gaudy sight to see at the showyard the great lusty lambs, nicely colored as to fleece, standing at racks filled with crimson clover, very crimson as to top and very darkly, richly green as to leaf. I think the clover is sometimes fed off there in hurdles as well. Crimson clover is strictly an annual, living less than one year. Commonly the seed falls to the ground in June, germinating in July or August. The plant makes growth during the cool weather or fall, and is so resistant to cold that it is green nearly all winter. With the first warm days of spring it is up and doing; it heads in May, perfects seed and dies.

Where Is Crimson Clover of Use?—Crimson clover is a plant for mild climates. It can not endure extreme frost. It has failed with me more often than it has succeeded in central Ohio. North of me along Lake

Erie it has succeeded with the orchardists, I think, about two years out of four. It is of no use in the cornbelt except in very favoring years, which is unfortunate, as it would be the best sort of legume for keeping our nitrogen, and enable us to follow corn with corn much more than we can now safely do. The home of crimson clover in America seems to be limited to Long Island, New Jersey, Delaware, eastern Virginia, the Carolinas and all the Gulf States. It is in use chiefly in New Jersey, Delaware and Virginia. There it is commonly sown after tomatoes or other truck crops, or in the corn at the time of last cultivation. In Maryland it grows in very poor, sandy soils deficient in lime, which it does not seem to need as much as do most clovers. I have seen it green all winter, even with a good many hard frosts and some freezing weather. It responds to fertilizers admirably, and in these poor sandy soils it is a godsend, accumulating nitrogen and humus, using the little dole of commercial fertilizer thrown in it in a most economical manner and returning with prodigious liberality. It is a plant for poor soils and mild climates. Nevertheless, it yields most on good soils, which it makes still better.

Steadily the region of crimson clover's domain enlarges as men know how to use it and soils become inoculated for it. After testing every one of the common clovers in Louisiana, I am convinced that crimson clover has more merit than any other for a winter-growing catch-crop, though I liked well there the mixture of crimson clover, bur clover and red clover. This use convinced me that the whole South should take up crimson clover and use it after corn and cotton as a catch-

crop; it should, indeed, sow fields of it especially for its soil-building effect, and to use as forage for winter grazing with pigs, calves and sheep. It should grow its own seed, which could easily be done, and learn to inoculate new soils, for this is one of the clovers that resents a raw, uninoculated soil. There are many legumes that will help the South, and this, it seems to me, is chief of them all at present, since it is tolerant of poor soils, and, growing during southern winters, would put the land to double use, besides stopping the waste of nitrogen from leaching of winter rains. The chief reason why crimson clover has not met with more favor in the South is that commonly it has been sown on uninoculated soil. Another difficulty is the dry weather in the fall that sometimes interferes with getting a stand, especially on clay or buckshot soils. Crimson clover grows commonly 2′ or more high, and stands erect with less tendency than red clover to lodge. It makes much less weight of hay than one is led to expect from seeing it grow. It is better fed green than made into hay. If fed after the heads begin to ripen, there is danger of death to cattle and horses from the forming of "hair balls" in their stomachs. While crimson clover makes good forage and is relished by all classes of animals, its chief worth is as a soil-renovating plant. It is sown in orchards to be turned under, after truck crops come off the land, or after corn or cotton. In Virginia it is commonly used as a forerunner of alfalfa. When thus used it is turned under when in full bloom, and the land afterward given good culture for some weeks till late July or early August, when the alfalfa seed is sown. It is very notice-

able that when one is endeavoring to bring up poor soils by the use of crimson clover, the more one helps the clover by means of manures the more the clover in turn is able to help the land. Thus it pays well to fertilize liberally when the clover is sown, choosing a fertilizer rich in phosphorus, and for some soils potassium. Crimson clover is less insistent than some clovers on lime in the soil, though it thrives best when the land is fairly sweet.

Bees revel in crimson clover, which is a good point. It makes seed very abundantly and the seed is easily threshed by either machine or hand. Crimson clover seed must be harvested at night or very early in the morning. Not a few southern farmers take squares of canvas to the field, and having the clover cut and dry, flail out the seed. This may leave the seed in the chaff, but for home sowing this is no objection; in truth, some believe it grows more surely in that condition. It may yield 5 to 10 bushels of seed to the acre. The yield of green forage from crimson clover may easily reach 10 tons to the acre. As a gatherer of fertility it may yield to the soil as much as 200 pounds to the acre of nitrogen, besides considerable good grazing, and all, practically, for the cost of seeding, since it grows mainly during the time between crops. I suggest to farmers living south of the Ohio River the establishing of small fields of crimson clover, if no more than plats in the gardens, whence can be taken soil to inoculate larger fields. For the small plat one can doubtless secure inoculated earth from experiment stations.

Sowing Crimson Clover.—Crimson clover seed is large and commonly of good quality. It is not often adulter-

ated. It can not be sown in the spring. July, August, September or October are the months of sowing, depending on location; the later months are best for the Gulf States.

Quantity of Seed to Sow.—From 10 to 20 pounds to the acre are sown. It is commonly sown alone. I have had good results mixing it with other clovers in Louisiana, though the crimson clover outgrew its rivals at first. The chief difficulty is to get the plants started at this dry time of year. It is not always safe to sow in the dust, since there may come a very slight rain that will sprout the seed without sustaining it. Besides sowing as a catch-crop in the standing corn, it may be sown alone on fields especially prepared for it. Thus sown in Louisiana we had best success, and it made us good pasturage for hogs. It may be mixed with rape seed, one pound of the latter to five of crimson clover, for hog pasture. One must not graze closely if one wishes to get the greatest good from the plant.

Crimson Clover as a Regenerator.—I feel that I can not urge too strongly the importance of this legume to the South. It comes at a time when fields are commonly idle, wasting and unlovely. It covers them over with a mantle of green. It stores them with fertility, adds humus and makes them mellow. It affords feed for plantation stock, commonly half-famished for something green and succulent, and is good for fowls and bees. The farmer once having his fields inoculated and a start of the clover, is able to save his own seed and have enough for himself and his neighbors. Crimson clover rightly used will lay the foundation for better things.

If the southern farmer is ready for no more, let him sow a single pound of seed in some good spot of well-prepared soil, nourish it and sow again the succeeding year, and, continually, till the inoculation is complete. From that little spot may radiate lovely fields in every direction; it may become the center of a new agriculture.

Crimson Clover and Cowpeas Together.—The "Southern Farm Gazette" contains the subjoined helpful letter written by W. C. Crook, Henderson County, Tenn.:

"We sow crimson clover alone in our corn fields at last plowing, at the rate of 15 to 17 pounds of seed per acre. From this sowing we nearly always get a splendid winter crop for our soil. But after careful experimenting we have almost abandoned sowing it alone at the last plowing of corn. We found by sowing it with cowpeas that, in case clover failed, we still had one leguminous crop and could follow with rye just the same. But when sown with peas we have but few failures with the clover. It is greatly shaded by the peas and thus protected while young from the hot sun and parching winds. The decaying peavines also protect and nourish the clover through the winter season. We also sow crimson clover along after wheat and oat harvest and get fine results. But here, as in our corn land, we get best results when sown with peas. By so sowing we can cut the peas for hay and still have the clover for a second hay crop, or to be turned down for green manure. We do the latter, as we get all the hay we can use from cowpeas, and it is a better grade of hay. The cowpea hay is not so good when sown with clover, as one must not sow over ¾ bushel of pea seed per acre. Therefore the hay is coarse.

"We find it pays to give land intended for peas and crimson clover a top dressing of 250 to 300 pounds phosphoric acid per acre. By doing this we are able to take very thin land and get a heavy crop of both peas and clover. We have made many experimental tests to see the effects of turning in a good growth of peas and clover; and always found the following crop to withstand a drouth splendidly, make a very rapid growth, and yield from 200 to 400 more pounds of seed cotton to the acre. In one test we found the wheat yield increased 7¾ bushels, and on another the corn yield

was increased 11 bushels per acre, where a growth of this kind had been turned down. We made a test with potatoes where a rank growth of crimson clover and decaying peavines had been turned, and found that we had not only gotten 18 bushels more potatoes per acre, but they were much smoother, more uniform, and freer from scab also."

Bur Clovers.—There are a good many species of bur clover that have more or less value. Among those most commonly seen are *Medicago maculata and M. denticulata.* These annual wild clovers were found originally in southern Europe, then naturalized in California, later coming into more or less use in our southern states. In California bur clover in the winter makes a lovely sight, much resembling our white clover, only of more robust growth. Animals eat it after they become accustomed to it, though it is not at first relished. After the forage is dry it seems better liked. In California it dries up after the rains cease, and remains dry and yellow till eaten during the long, dry summer. After it is eaten the earth is found covered with the burry pods, which are greedily licked up by cattle and sheep. The burs of some species become entangled in the wool of sheep and are more or less troublesome. Bur clovers are relatives of alfalfa, and carry the same bacteria. They enrich land on which they grow, as do all clovers, and, as they grow in winter, have distinct value. Growing with Bermuda grass it is objected that animals do not eat the clovers, and they tend to make too rank growth and to smother out the grass in patches. In Louisiana I have seen bur clover growing luxuriantly along the Mississippi River, and have tried to establish it by sowing the seed. It seems less easy to establish than crimson clover,

and of less value, on the whole, though it has the merit of reseeding itself, once established. I approve of bur clover, as it is a nutritious, soil-enriching legume, and advise southern farmers to make effort to establish it along roadsides and in pastures, which it would beautify and enrich. It seems to like a soil rich in lime, and to need inoculation.

There is a new bur clover, *Medicago obiculata,* that makes a most astonishingly vigorous growth in California, affording of dry forage as much as 4 or more tons to the acre, and leaving when raked away many bushels of seed on the earth. This clover is said to be somewhat tender, but it should thrive in southern Texas and the Gulf States. In California this bur clover would afford 20 times the amount of summer feed that is now had from native wild growth, and is well worth testing. It may need to have stock kept off it till it has nearly matured, in which case one could have a fenced pasture of *Medicago obiculata* and another pasture of native wild oats and smaller bur clover. Seed of all these bur clovers is obtained by removing the vines and sweeping the seed from the dry ground with wire brooms. None of them is of any use in the northern states, but all have their uses in the South and should be taught to grow in pasture and as catch-crops. One of the first men to call attention to the value of bur clover was Dr. Tait Butler, then of North Carolina, now editor of the "Southern Farm Gazette," from which valuable southern farm journal I quote:

"The chief use of bur clover is as a clover crop during the winter and spring, to gather nitrogen for soil improvement, and as an

early pasture. It is an annual and must be sown every year or sufficient seed allowed to ripen to re-seed itself. It makes an early spring growth and sufficient seed will ripen from May 1 to May 20, according to location, to re-seed the land. In two years' experiments on one of the test farms of the North Carolina State Department of Agriculture bur clover produced sufficient growth of hay to yield an average of $28.27 worth of nitrogen per acre at current prices in mixed commercial fertilizers. On two plats fertilized with the same quantities of phosphoric acid and potash, but the one having grown a crop of bur clover and the other having been fertilized with 120 pounds of cottonseed-meal, the bur clover plot gave at the rate of 400 pounds more seed cotton per acre. At 4 cents a pound for seed cotton this would give an increased profit of $16 per acre. The increased cost of picking, and the like, would be covered by the 120 pounds of cottonseed meal used on the other plot, which would leave a net profit of $16 for the crop of bur clover. That a heavy crop of bur clover was grown is shown by the fact that nearly three tons of hay were obtained as an average of two years' trials on this farm, but half that growth would yield a profit sufficient to more than justify the use of this plant as a winter cover crop on the cotton fields.

"Its chief value as a pasture crop is in the fact that it affords pasture during February and March when there is a scarcity of green feed. While it is a legume, and rich in protein, it is not readily eaten by stock except when other more palatable green feed is not obtainable. It grows on a great variety of soils and will, under proper conditions, probably do well practically throughout our entire territory. Bur clover may be sown at the last working of the corn or cotton crop. In fact, that is probably the best time to sow it if seed in the bur is used instead of clean seed. It takes the burs some time to rot and unless sown in July or August a stand is not so certain. If clean seed are used, later sowing may be advisable. The seed may be sown broadcast and lightly covered with a cultivator at the last working. When level cultivation is practiced this will be found satisfactory, but if the turn plow is used in cultivating, the seed may be covered too deeply unless a very large quantity is used. After the seed burs ripen they fall to the ground and are usually swept up in gathering the seed. In this way more or less soil and trash are gathered with the seed burs and sufficient of the germs or bacteria usually adhere to the burs

to inoculate a fresh soil if a liberal quantity of seed be used—about two bushels to the acre. If clean seed are used, it will be necessary to inoculate the soil in some way if bur clover has not been recently grown successfully on this soil, and the most satisfactory way to inoculate—as for any of the legumes—is to obtain a few hundred pounds of soil for each acre, from a field that has produced a good crop of this clover. Even with the seed sown in the burs, complete and satisfactory inoculation is not usual the first year, but the second year it usually becomes sufficient. It is usually claimed that soil that has grown alfalfa or melilotus successfully is inoculated for bur clover.

"Many failures to obtain a stand of this plant are recorded and in the opinion of the writer they are most often due to sowing too late, when the seed are in the burs, and to the lack of inoculation. There is probably no winter cover crop from which the best results can be obtained in time to prepare the land again for cotton. For this reason, as well as for many others, some other crop should follow the cotton and bur clover. If corn be planted after the bur clover, ample time exists for the ripening of the clover, the proper preparation of the land and the growth of the corn crop. As soon as enough of the bur clover has ripened to insure re-seeding of the land—May 1 to 20—the land should be well broken, thoroughly harrowed and the corn planted. We advise those who are thinking of trying bur clover for the first time, to sow only a small area, say one acre. Procure seed in the burs and also, if practicable, 200 to 500 pounds of soil from a field where the crop is now growing well. Sow the latter part of July or in August, and after a success has been achieved on one acre the seed and the inoculated soil are at hand for sowing several acres if desired. As a cover crop and soil improver bur clover is worth much more than it will cost to grow it, but get your soil inoculated and learn how to handle it before you try it on a large scale."

Sweet Clover (*Melilotus alba, M. officinalis*).—This plant resembles alfalfa, and is closely related to it. When young it is hard to distinguish from alfalfa unless one tastes the stem or leaves, when its characteristic bitter taste is discovered. It has also a distinct odor that gives it its name "sweet clover," and this odor it retains when

made into hay. There are two species, white and yellow. The yellow-blooming variety *(M. officinalis)* is smaller and of less value than the white-blooming one, though it lacks the troublesome coarseness of its relative, *M. alba.* Sweet clover is a biennial, starting one year and making no attempt to bloom, blooming the second year and dying. Seed may drop so that there will be a continuous growth on the land, and sometimes men sow the seed for two years in succession so as to have it in continuous growth. Of few plants has more been said for and against. Some states have proscribed it as a noxious weed; others have expressly stated that it was not a weed at all. Men have, without reason, feared it and cursed it; others have with care established it and are using it as a bee pasture and as forage, both green and dry, for cattle, sheep and swine. Sweet clover has a marvelous luxuriance of growth. I have seen it full 8′ high, and that on very hard soil, but rich in carbonate of lime and phosphorus. It carries the same bacteria as alfalfa, and enriches soils in the same manner. It is the most vigorous soil-enricher of any of the clovers and will do what the others will not, that is, begin on very poor worn soils. It luxuriates on poor hillsides and in time covers them over with good grasses. It grows on old, worn fields in the South and is grazed eagerly by lambs, ewes, pigs and calves. It is occasionally made into hay, and the Wyoming Experiment Station has shown that lambs fed on this hay make as much gain as on alfalfa, or even a little more. It is the best bee pasture extant, and it will grow on soils too hard and too deficient in humus for alfalfa. After growing for

a time the land will grow the better legume. All in all, there is hardly a better legume than sweet clover, and none that can fill its place. Withal, it has not fulfilled

Sweet Clover.

Roots of Red Clover showing nodules.

the hopes of its friends. It seems a capricious plant. Growing luxuriantly on the roadsides or along railway embankments, it becomes a sickly, insignificant thing sown on cultivated fields. The truth is that sweet clover

is a lime-loving plant. It will grow anywhere that the soil is filled with carbonate of lime; rich or poor, sweet clover will enrich a lime soil. It can not be established on a soil deficient in lime. It must be inoculated in order to thrive anywhere, but inoculation in right soils comes easily and soon, whether artificially applied or not. It is a splendid forager for food and if it has its lime-hunger satisfied is not exacting in other things, and is, indeed, far less exacting than any other legume that I know.

Sweet Clover Nowhere a Pest.—I have never seen sweet clover do injury to any cultivated crop. In the meadow it disappears completely under ordinary mowings, since it can not seed. In pastures it seldom comes, since animals graze it when young and prevent its seeding. Along ditches, roadsides and in waste ground it may grow thick and rank, but there it is better than weeds since it feeds the bees and is beautiful when young. Men unused to it are sometimes annoyed or frightened if it comes in their new-sown alfalfa meadows. Nearly all western-grown alfalfa seed contains more or less sweet clover and few can distinguish between the seeds, nor is it possible to separate them. The melilotus will do no harm in alfalfa and will disappear in two years of ordinary use of an alfalfa meadow.

The Use of Sweet Clover.—I have watched for years the steady spread of sweet clover over certain hillsides and mountainsides of Kentucky. When first I knew them they were washed, gullied and nearly barren. They are stony hillsides and contain much carbonate of lime. Now they carry thousands of fields and patches of sweet

clover and present a very beautiful appearance in spring and early summer. Sheep, pigs and cattle graze this melilotus and stock-buyers comment that they get their best lambs from these farms. Further, on these once bare hillsides, the bluegrasses are coming in, following in the wake of sweet clover. It is made into hay, and horses, cows and sheep eat it with relish. It is necessary for animals to learn to eat the plant, and probably they would always prefer the other clovers, yet they thrive as well, apparently on the sweet clover as on any other forage. In the limestone soils of Alabama and Mississippi sweet clover is doing wonders, and some farmers in those regions claim it to be more profitable than alfalfa. In Colorado and other western states it is being sown on very hard adobe soils to prepare them for alfalfa, the practice being to turn it under when at the height of its growth. It is found to have great power to mellow hard adobe soils.

Establishing Sweet Clover.—Only on soils too poor or wet for alfalfa would I suggest sowing sweet clover. The seed is sown in much the same manner as alfalfa—in the fall in southern climates and in the spring or summer at the North. The land should be well limed if it is at all lime-hungry. Carbonate of lime gives best results with sweet clover. What sweet clover especially does is to secure nitrogen from the air by means of its bacteria, and these live only in soils rich in lime. It must have inoculation or it is a poor, sickly thing. Inoculation can be had by sowing soil taken from a rank-growing sweet clover patch or from an established alfalfa field. Wherever nature has put lime in the soil or one can buy

it, one can grow either sweet clover or alfalfa; the sweet clover may very easily be a forerunner of the better legume. I am firmly convinced that there are millions of acres in the United States that would be far more profitable sown to sweet clover than they are today, for they would then be made ready for corn or alfalfa, and the sweet clover would yield honey, wool and meat, while doing its work of soil restoration. Especially has it immense value as a soil ameliorant. There are vast areas now being reclaimed by irrigation that have most difficult soil, hard and clayey, difficult to irrigate and to till. These soils are rich in mineral elements of fertilization. They lack nitrogen and humus, something to open them and let in air and water. Sweet clover thrives on these hard, lime-impregnated lands and should there be grown. When it reaches full height it should be turned under. Money could be made by saving a seed crop, too, as sweet clover seed sells for nearly as high a price as alfalfa seed.

Yellow Trefoil (*Medicago lupulina*).—I would not mention this little clover only that it so often comes where it is not expected, and causes owners no end of wonderment. It is a small, creeping clover with a yellow bloom. It is harmless and makes good grazing, though not very much of it. In Europe, it is sometimes sown with intent. In America, it is gotten only as an adulterant with alfalfa or clover seed, chiefly with alfalfa. It may do much harm in alfalfa by crowding the better plant while it is young; otherwise it is not a weed, and the worst about it is that one is deceived when one buys it and is defrauded.

Hairy Vetch (Vicia villosa).—There have been introduced into America many species and varieties of vetches. Some are sown in the spring and some in the fall. There is also much variation in the vetches themselves, that they might well be divided into varieties of greater or less merit, would anyone take the trouble. The spring-sown vetches are not adapted to our hot dry summers, and practically the one species in cultivation in America is the hairy or winter vetch. Hairy vetch has several very strikingly good qualities. It is very hardy. It grows late in the fall and early in the spring. It is tolerant of poor soil and is especially adapted to soils deficient in lime and humus. It grows better in good soil and is grateful for being fed. It is a heavy carrier of root tubercles and these increase more during colder weather on vetches than on most legumes. It makes good forage that is relished by all classes of animals. It gathers more nitrogen than anything else that can be sown for a winter-cover crop. It is adapted to all the South where it grows nearly all winter and is hardy in New York. Hairy vetch is a slender, vine-like, trailing plant with pinnate leaves and tendrils on the ends of the leaf stems. Its blooms resemble small purple or bluish peas, and later pea-like pods with small, round, black pea-shaped seeds. The vines may grow 4, 6 or 8 ft. long, then recline on the ground, unless they find something up which to climb. It is useful to sow rye or wheat with vetches so that they may have support. In the north rye may be the better plant; from Tennessee southward wheat is better. The mixture of vetch and wheat makes a prodigious amount of forage for spring cutting which may be used for soil-

Hairy Vetch (Vicia villosa).

ing cows or other animals. I have seen astonishing growths of this plant in Oregon, Washington, Tennessee, Alabama, Mississippi and other states. It is not, so far as I have seen, regularly in use by farmers anywhere.

The difficulties as to vetch are several. The seed is expensive, costing now (1910) 6 cents a pound, and it requires 70 to 75 pounds to the acre for a good seeding. Then the seed lies in the earth sometimes for a year or more and may come up in small grain and prove a troublesome weed, though it will not interfere with any cultivated crop. It must absolutely have inoculation or it makes very slender growth. I know of no legume depending more on its bacteria than the hairy vetch. In Louisiana I sowed vetches on sandy loam soil, well worn, with the result that few plants exceeded a foot in height, while a few plants accidentally inoculated made a growth of many times that. I should say from observation that on poor soils there would be more than 10 times the growth of hairy vetch where the soil is inoculated over where it is not. The Alabama station reported a growth of 232 pounds to the acre without inoculation and 2,540 pounds with inoculation.

In the South vetch may be sown on Bermuda grass sod, which may be disked or even plowed to give a seedbed. It should, however, be grazed off close, or mown as soon as hot weather begins, otherwise its shade will destroy the grass. At the Cornell station in New York three months' growth of hairy vetch made 6,824 pounds of dry forage per acre containing 240 pounds of nitrogen, 53 pounds of phosphoric acid and 52 pounds of potash, while during the same period cowpeas produced 2,262

pounds of forage per acre, containing 46, 23, and 19 pounds respectively. It seems to me the one serious obstacle to cultivation of vetch is the cost of seed, and this the farmer could in a measure obviate by growing his own seed—a thing easily enough done. Vetches germi-

Hairy Vetch.

Cowpea.

nate slowly and should be sown early—in northern latitudes in late July, in the South as late as October and in the Gulf States it may thrive sown in November, though earlier seeding is desirable if there is moisture sufficient to germinate it. Inoculation may be given by immersing the seed in very muddy water, made by stirring in-

fected earth from some inoculated vetch field into a bucket of water. This will give a thin coating of mud on each seed and the inoculation will be found efficient. The seed should be sown at once without exposure to light.

Vetch and Crimson Clover.—My friend, L. W. Lighty of Adams Co., Pa., a shrewd, practical Dutchman, has this to say in the "National Stockman and Farmer" about the use of these two legumes in Pennsylvania:

"Sow any time after the middle of July to the end of October. If you never grew vetch before it may not succeed so well the first year as it, like all legumes, does better on inoculated soil and the inoculation comes from the growing of the plant. My preference is to sow a half-bushel of vetch and a bushel to a bushel and a half of rye to the acre. If you do not care to plow early in the spring, and the land is fairly fertile, a peck of vetch and three pecks of rye will make quite a mass of vegetable matter. I prefer heavy seeding so as to get a dense growth and prevent washing during winter and it also gives me more material to plow under early in the spring. Would it pay to sow vetch the last working of corn if the stubble is to be sowed to wheat? No, the growth of the vetch is best in cool weather, so you would have but little growth, besides it would be hard to destroy all the vetch plants and they would be in your wheat like cockle, and almost impossible to separate if you would wish to sell the wheat. Vetch, like rye, may be a weed and you do not want it in your seed or selling wheat. Would not crimson clover be preferable to vetch? It may be, in fact is, in some soils preferable to vetch. I note wherever there is a good proportion of sharp sand in the soil, crimson clover flourishes, but in the clayey or shaley soils, devoid of sand, crimson clover is an unsatisfactory manurial crop because it thrives so poorly. Rye and vetch are generally preferable because they grow and thrive under the most adverse conditions. Being a sort of weed, they flourish in spite of neglect, do not winterkill, nor do insects disturb them. Crimson clover is delicate and wants things just so or it will quit. I prefer the robust, rough-and-ready plant that is there when I come to plow it under. If crimson clover succeeds on your soil

sow it, but rather than have the soil lie bare during winter, by all means sow rye and vetch. As a soiling crop this rye and vetch mixture is superior to the crimson clover."

Japan Clover (Lespedeza striata).—Japan clover came to us probably in packing about tea chests or china ware in 1850. It spread rapidly over the South during the Civil War, and is now found nearly everywhere south of the Ohio River, especially on poor soils where bluegrass and other perennial grasses are not seen. It is most abundant and luxuriant in the Gulf States. It has an astonishing ability to grow on poor soils, yet makes most growth on rich soils. Ordinarily it is only 4″ to 6″ high; in Mississippi and Louisiana on rich bottom lands it may be 2′ or more high and make 3 or more tons of hay to the acre at one cutting. Japan clover is abundantly supplied with large, firm nodules and is an efficient nitrogen-gatherer, greatly enriching soils on which it grows. It is an annual clover and comes each year from seed. It seeds well, and, once established, is nearly permanent unless the land is cultivated. Animals can hardly graze it close enough to prevent its seeding, since when close-grazed it sends out, close to the earth, branches that bloom and bear seed. When undisturbed it has an erect growth, especially when growing thick on rich soil.

All animals relish Japan clover and thrive on it. It is invaluable as an admixture with Bermuda pasture. It is said to uproot broom sedge, though I doubt its ability to do this on ordinary soils. It is not insistent in demanding a good soil or a soil rich in lime; in fact, it will grow on a greater variety of inferior soils than any other useful clover. Japan clover "comes of itself" on many soils,

yet it is being more and more sown with profit, especially along the rich alluvial lands of the lower reaches of the Mississippi River. It is not intolerant of occasional flooding of the ground so the water does not stand too long or become too deep, hence it is adapted to poorly-drained southern lands as well as to hillsides. I have seen it grow luxuriantly on hard subsoil along railways where every bit of the topsoil had been removed. Speaking for Oklahoma, John Fields remarks that it is not worth while sowing lespedeza where it does not come of itself; that it is not adapted to drouth conditions. In Louisiana it is often sown with winter oats, the oats being sown in the fall and the lespedeza in the spring. After the oats are taken off, the lespedeza uses the land effectually and makes a crop of hay in the fall. The seed is best sown on bare earth and either left uncovered, when it will be covered by the beating rains, or else lightly brushed in. It will not endure much earth upon it. It may be sown at any time in spring or late winter.

Quantity of Seed to Sow.—Ordinarily the seed is sold in the pod and a half bushel or more is sown to the acre. If one gets at first a thin stand of lespedeza, one may hope that the second year it will have thickened by its own self-sown seed. In mowing lespedeza for hay, one must use caution or one will lose the stand. When it grows thick and tall there is danger that the mower may cut off all the bloom and seed. Some growers remove two or three sections from their mower knives so that strips are left uncut for the purpose of maturing seed. Lespedeza hay is richer in fat than alfalfa and compares well with it in all points. It is probably a more valuable

hay. It is highly prized wherever it has been fed. Many old abandoned cotton plantations since the advent of the boll weevil have been sown in part to lespedeza with first-rate profit. It is common to mow it off early in the summer to remove the weeds and wild growths so that the lespedeza hay may be nearly pure.

After studying the problem of live stock production in the Gulf States for several years, I am convinced that this clover should be the first to be sown. It has not as high value, acre for acre, as vetches or alfalfa; it will not grow to add fertility in frosty weather; in fact, it is a very tender annual, but it is so humble, so little insistent on good treatment, that one can take an old field too poor and undrained for good farming, plow lightly, level off, and sow to lespedeza, and presto! one's land is occupied, at work, and getting richer even if slowly, will support stock, and more than hold its own till one can get ready to take it seriously in hand with drains, deep plowing and fertilization preparatory to growing the larger legumes or corn. On the richer parts of his land he can grow from 1 to 4 tons to the acre of prime, nutritious hay if he feeds it, and bringing a good price if he sells it.

Sainfoin (Esparcette) and French Clover (Onobrychis sativa).—I have never seen a successful field of this beautiful and valuable clover in America. In France it is much used both in mixtures with alfalfa (lucerne) and other clovers, and sown alone. On the best farms near Paris it is nearly always a part of the composition of the meadow. In England it is highly esteemed for dry, calcareous soils. It is somewhat slow to establish but when

it is developed it is very productive and the hay is of superior quality. It likes dry, calcareous soils which it is said to enrich remarkably. It seems altogether unreasonable to me that it should not find somewhere in America a congenial soil and climate. I have tried it in Utah with only moderate success. I suggest that probably this clover is only another instance of the necessity of inoculation. True, most soils in America are lime-deficient, yet there are other soils in the West and Southwest that have a considerable excess of lime in their composition and are well drained. I have seen soils in Colorado, New Mexico and Texas with from 4 per cent to 25 per cent of carbonate of lime in their composition, surely enough to satisfy even sainfoin. It is not worth while for the farmer to work with sainfoin before his experiment station has shown him how to grow it, though I assuredly look for it to come into use in America some day. There are hills of limestone gravel in northern Illinois and southern Wisconsin that should take it; there are limestone hills in Kentucky now growing sweet clover that might take it, and then the vast areas of lime made soils of the Southwest. I suggest to directors of experiment stations that they secure from some source, perhaps from the farms of France, soil in which good sainfoin is now growing, choose a dry plot of land, lime it very heavily with carbonate of lime, and make serious effort to learn what inoculated sainfoin will do in America.

Quantity of Seed to Sow.—In Europe it is common to sow about 60 to 80 pounds of unhulled seed to the acre. Clovers or alfalfa are sometimes sown with the sainfoin. The seed can not push up through any great depth of

earth, so the seedbed must be fine and level so that the seeds may be put in at a uniform depth of about 1″ or a little less. It is sown in spring. In Europe are fields 20 years old in productive condition. It endures drouth well and has enriched many poor, half-barren, hilly, calcareous lands of Europe. I venture here to prophesy that we shall learn to use this splendid clover some day in parts of America and that it will do us great good. I would never sow it without inoculation, and at this writing that is difficult to secure.

Field Pea (Pisum sativum var. arvense).—Field peas must have mention because they are of importance in Canada, Michigan, Wisconsin, New England and northern New York and in high altitudes of the western mountains. They are a close relative of the common garden pea, a mere variety, more resistant to cold and hardier to endure field conditions. They produce smaller peas than the garden sorts, and are smooth, while garden peas are commonly wrinkled. The growth of vine is remarkable, the Golden Vine variety having a length often exceeding 10′. As the vines get older the leaves drop and the stems become bare. The Utah station reports the greatest yield of both green forage and dry matter when the plants were in bloom, water-free substance, 4,997 pounds to the acre. Field peas are commonly grown for soiling purposes, mixed with oats. They grow best in cool weather and should be sown as early as possible in spring. In some soils they may, indeed, be sown very late in the fall, just as winter sets in, and they will lie dormant till early spring and then grow. Because sandy soils are first dry and warm in spring, field peas are commonly found to thrive best there. They like calcareous

Canada Pea.

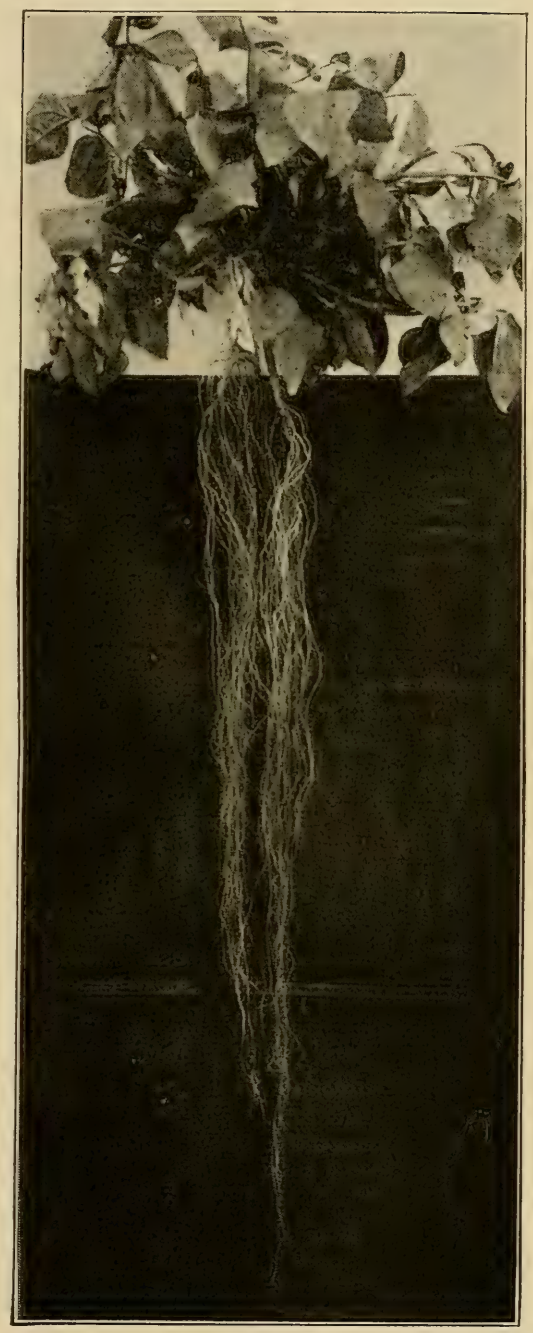
soils or soils having been well limed. They need the right bacteria in the soil to cause nodulation of their roots, but commonly this is naturally present. Any soil that grows common garden peas well will inoculate field peas. They should be sown deeply, on deeply-plowed land. Often they are covered with the plow or drilled in very deep. In the Gulf States they should be sown in November; they will often make growth in mild winters.

Quantity of Seed to Sow.—From 1 to 3 bushels to the acre are sown. When in drills, 2 bushels will be found sufficient seed. Wheat is, in the South, a better crop to sow with peas than oats, the standby of the North. Peas have considerable power to enrich soils, as was shown by their behavior in the San Luis Valley of Colorado. Lands there long devoted to wheat ceased to produce well and were sown to field peas, the seed coming first from the Mexicans. The peas throve and were either grazed off by sheep and pigs or mown and fed in corrals in winter. Afterward an astonishing rejuvenation of the soil was observed. The peas also proved very profitable as fattening feed for lambs, sheep, cattle and pigs. The altitude there is about 7,000 feet. Irrigation furnishes a soil always moist and the climate is cool with especially cool nights. There are other valleys in the Rocky Mountains too high for alfalfa and cool enough for peas, which do not resent an occasional light frost. The dry winters usual to those regions permit the feeding off of the peas with very slight expense, and the manure made is dropped on the land.

In the cornbelt region peas are little used, and in central Ohio they have with me proved less profitable than

other forage crops. I have confidence in them for the North, the mountains, and the South where there is warmth enough for them to grow the winter long.

Cowpea.—The cowpea, called appropriately in Europe the China bean *(Vigna sinensis or Vigna catjang),* is not properly speaking a pea, but resembles more the garden bean. It is an annual plant of great importance in the South, and, though not properly making either meadow or pasture, must have brief mention here. The strong points of the cowpea are that it will grow on very poor soil, and that it is very soon inoculated by natural means,



Cowpea plants with roots 41″ long.

though inoculation may come sparingly the first year. It enriches soils, as do all legumes, but for enriching quite poor soils it is perhaps better than almost any other. It makes good forage somewhat difficult to cure into hay. The seeds are good food for man or beast. It is not insistent on the soil being sweet, as are most legumes, but it will not grow in wet soil. The richer the soil is in mineral elements the better the growth of peas. It gathers sufficient nitrogen from the air by the aid of its root nodules and bacteria, but must have phosphorus and perhaps potassium fed it, the latter being most commonly needed on sandy soils. There are very many varieties of cowpeas; among the most common in use are Whippoorwill and Unknown used in the South, and Black, a good variety for the North, though it may not mature seeds there. The Iron pea is immune to the cowpea wilt, so it has value in regions subject to that disease. There is also a wild cowpea growing in Louisiana that perpetuates itself from year to year and makes much forage. The northern limit of profitable cultivation of the cowpea is probably the same as the limit of the larger dent varieties of corn, though it can be grown much farther north and will do fairly well. As cowpeas love sun and warm soil, it is not well to plant them until the earth is warm, say 10 days or two weeks after the usual corn-planting time. The lightest frost is fatal to the cowpea.

Method of Seeding Cowpeas.—To secure a good crop of peas one should plow and prepare the land well. The seed is better sown in drills 30″ or more apart, and cultivated once or twice. Two or three pecks of seed will sow an acre in drills. A larger amount of seed is com-

monly secured when planted in drills, but for hay it is common to sow broadcast and cover by disking or with shallow plowing. Thus sown, a bushel or more of seed is required if the crop is to be mown off for hay. The

A Rack for Curing Cowpea Hay.

cultivation should leave the land as level as is convenient. Since cowpeas are weak-stemmed plants, it is desirable to plant something with them that will hold them up. Soybeans planted thin are used for this purpose, as also is sorghum. The latter makes good growth with cow-

peas and together they make much good forage, though it is hard to cure.

Making Cowpea Hay.—There is no easy way of making cowpea hay. The Tennessee station uses frames made of four upright timbers about 9′ long, bolted to-

Cowpea Hay Cocked Over a Rack.

gether at the top and spread below like a tripod with cross pieces that hold the vines off the ground. On these frames green forage can be cured in large cocks of maybe 500 pounds weight. In Bulletin No. 40 of the Mississippi station is given an account of how to cure cowpea hay.

The mower is started in the morning as soon as the dew is off, and run till noon. As soon as the top of the vine is well wilted it is run over with a tedder. When the crop is very heavy, the tedder is used a second time. Vines that have been cut in the morning and teddered in

Cowpea Hay Rack Ready for Moving.

the afternoon are usually dry enough to put in small cocks the next afternoon, and if the weather promises favorable they are allowed to remain in the cocks for two or three days before they are hauled to the barn. If it should rain before the vines are put in cocks they are not

touched until the surface is well dried, and are then teddered as though freshly cut. We find the only safe plan is to put the vines in a stack covered with straw for a few weeks, or, still better, in the barn, where they should not be piled too deep. After a month the hay may be baled with safety if it appears then to be well dried out.

Harvesting Cowpea Seed.—Commonly the seed is picked by hand as the pods ripen, negro women usually doing the work. This is a rather slow and costly method. The vines may be cut and threshed with a special pea thresher. After being threshed the haulm is readily eaten by stock. The use of this machine should make cowpea seed cheaper, the chief difficulty in using the plant having been the cost of seed.

Cowpeas in Corn.—Cowpeas are commonly planted in corn at the time of the last cultivation. They may be sown broadcast or put in with a drill. In the South there may be much growth during and after the ripening of the corn, and a notable gain in fertility. The peas may be harvested or fed off by pigs or other animals or all the growth left to enrich the soil. The peas may be drilled at the time the corn is planted, or soon after. Thus planted they may make too much growth for the best development of the corn, though some experimenters believe that the corn is fed with nitrogen directly from the association of the peas. The mass of corn and peas may be put into the silo. Commonly, soybeans planted with corn give better results for the silo.

The Cowpea as a Soil Enricher.—The cowpea is to the South what clover is to the North and alfalfa to the West. It is a stepping-stone to sufficient fertility

for better farming. Long southern summers are longer than the corn crop can utilize; the cowpea fills in the space and keeps the land busy till fall, meanwhile gathering humus-making material and nitrogen. Two tons of cowpea vines to the acre equal in nitrogen content 600 pounds of nitrate of soda. The cowpea may not always enrich soils. Mooers found at the Tennessee station that where cowpeas and wheat alternated in rota-

Cowpeas in a Southern Field.

tion, and the peas were removed from the land, the yield of wheat was reduced over adjacent plots where wheat followed wheat. In Louisiana, turning under cowpeas increased the yield of sugar-cane the first year 2.91 tons, the second year 3.69 tons and the third year 0.82 tons. The soil on which this cane grew was the alluvial soil of the Mississippi River Delta, fully supplied with phosphorus and potassium, lacking only nitrogen and humus. The Delaware station finds that a maximum crop of al-

falfa yielded 1,230 pounds of protein (containing 200 pounds of nitrogen) per acre while maximum crops of cowpeas and crimson clover yielded about 725 pounds each of protein (115 pounds of nitrogen) per acre. Since cowpeas and crimson clover may be grown on land where alfalfa fails, they will perform its work. It is not worth while growing cowpeas where alfalfa thrives, except that they may help prepare the land for the better perennial legume. In Virginia cowpeas often precede sowing land to bluegrass, and with marked results.

Comparing Cowpeas with Soybeans.—I have tested these plants side by side in Louisiana, and concluded that in nearly all ways soybeans were superior. The soys made more forage and more seed and were more easily harvested. Cowpeas, however, are better adapted to rude methods of cultivation, and may do more to smother out weeds.

The Field of the Cowpea.—To utilize the soil left vacant by ripening corn and gather nitrogen for a succeeding crop, to prepare poor land for cultivation, to yield nutritious forage hard to gather but worth the effort on the southern farm, to store in the soil humus and nitrogen to help a following crop, to make a catch crop for feeding off the land with hogs, to furnish southern farmers with a ready source of protein for dairy or feedlot—these are among the uses of the cowpea. It is hardly comparable with clover or alfalfa, but even on farms where these may grow it will often find temporary use.

Velvet Bean (Mucuna utilis).—This is a bean having a liking for hot, moist weather and sandy or fairly well-

drained soils. It is a rampant grower and will make vines 30′ to 50′ long in a season and in Florida will produce 20 to 30 bushels of beans per acre. It makes over the land a dense tangle of vines that are commonly allowed to lie for a year and decay, before they are turned under. Hogs and cattle thrive on the beans. The vines

Velvet Bean, showing leaves, flowers, and young pods.

are sometimes made into hay and yield from 2 to 4 tons per acre. The effect on the soil of velvet beans is much the same as of cowpeas, but they are not adapted to northern latitudes. On Woodland Farm, in central Ohio, they made one year a respectable growth, but animals accustomed to other forage would not eat them

well green. The soil-enriching powers of velvet beans are about the same as of cowpeas. The effect of growing them in sandy soils far south is most beneficial, and is much enhanced when they are liberally fertilized with phosphorus and potassium. Much better results with velvet beans would be secured if the vines were turned under and, the year following their growth, the field planted to some crop that could utilize the nitrogen gathered. This could readily be done with the large disk plows made for deep tillage.

Soybean (Glycine hispida).—This plant gives promise of becoming a great factor in American farming, especially in regions parallel in location to Kentucky and Tennessee, though it thrives well as far north as the 40th parallel and is grown more or less for 100 miles farther north, and as far south as central or southern Louisiana. There are many varieties of the soybean which have been grown as feed for men and animals for untold centuries in China, Japan and Korea. It is a comparatively recent comer to America, but already promises to displace the cowpea in many situations and to supplement corn in rations for farm animals in such states as Tennessee, Oklahoma and Kansas. At present, its most enthusiastic advocates are properly to be found in Tennessee, where soil and climate and habits of men seem congenial to it. The soybean is distinctly unlike any other legume. It commonly stands erect, though there are trailing varieties, has strong, hairy stems, a strong tap root, broad leaves, small, purplish flowers, and short pods downy and with rather few seeds. The pods are often attached to the main stem

A Soy Bean Plant.

and branches. The seeds are of several colors: green, yellow, white and black. Soybeans seem to have more varieties and variation than the cowpea. They vary in height from 2′ to 6′, and in time of maturity from

90 days to so long a season that they will mature only in the region of cotton-growing. Soybeans love sun and thrive best if planted when the earth is warm; they are not hurt by cool weather so much as cowpeas and may be planted somewhat earlier, though it is better to plant them a little later than one plants corn. They are best planted in drills as close as can be consistent with the use of horse cultivation. I have had good success spacing the rows 2′ apart, though for large horses a little more room is desirable. The beans are not easy to get up. The soil should be made fine and level so that they can be drilled in at uniform depth, and the seeds must not be deep, about 1½″ being the maximum depth allowable.

Quantity of Seed to Sow.—The amount of seed required is about 20 pounds per acre. It pays well to cultivate soybeans carefully till they cover the ground and shade it enough to keep down weeds. When the seeds are ripe comes the problem of harvesting the crop —a problem yet in solution. The most economical way, if one wishes to avoid loss of beans, is to cut with a short, strong scythe one row at a time, or to use a hand knife like a strong, short sickle, taking hold of the plants with the left hand, cutting them off and laying them aside in bunches to dry. Commonly they are cut with mowers or self-rake reapers and left to lie a few days in the sun to dry. They may then be threshed with a common thresher or a bean thresher. There may be much loss from the pods popping open as the plants lie drying on the ground. Pigs can afterward glean the field. When cut for forage they are mown off before

Typical Soy Bean Plant.

the pods are ripe, and made into hay. They cure far more easily than cowpeas.

Soybeans and Inoculation.—It is a curious fact that soybeans will, if grown on the same ground consecutively, inoculate themselves the second year. There is yet some undiscovered reason for this fact, which was first pointed out by Prof. H. Garman in Kentucky Bulletin 98, page 19. Certain varieties of soybeans become inoculated much sooner than other varieties—another unexplained fact. One should always, where possible, grow soybeans for two or more years successively on the same land. Artificial inoculation is very easily performed; one can take earth where inoculated soys have grown, make it fine by sifting, wet the seeds just as one is ready to plant, and mix with them the dry, sifted earth till they are dry enough to plant. Or, one can simply drill the dry, sifted earth along with the beans, which may work better with machine-drilling. Unless the soil is very rich, the growth with inoculation will be much better than without. The nodules of soybeans are very large and the amount of nitrogen secured from the air must be considerable.

Uses of Soybeans.—The whole crop may, mixed with corn, be put into the silo, and it is believed that thus cows may have their protein cheaply supplied. Tests with beef cattle do not show superiority of this mixed silage over that from corn alone. The beans may be fed as a soiling crop, and this is one of the best uses. The seeds may be allowed to ripen, threshed and ground and fed to pigs to furnish protein for balancing a ration of corn. Remarkable results have been achieved in this way,

as one can find by consulting bulletins of the Kansas, Oklahoma and Ohio stations. The crop may be fed off by cattle on the ground, followed by pigs to glean the fallen beans, and thus remarkable gains have been shown. The Tennessee and Alabama stations have published valuable bulletins detailing work in this line. Soybeans may be cut for hay and results from feeding the hay show that it is about as good as alfalfa. When cut for hay the

A Field of Soy Beans in Tennessee.

best varieties are the Mammoth and Ito San. For hay soybeans should be cut when part of the seed is formed, but before the pods ripen. Nothing will make more or better growth with lambs than soybeans fed in connection with other grains. The composition of soybeans is such that it has a very high feeding value. Its protein content is about 35 per cent and its fat 20 per cent. There is no starch in the soybean. In Japan an artificial milk is said to be made from the beans, and they

are employed in many ways as food for men. They are slow to soften with boiling, but if ground into meal make delicious soups and porridge. We have grown them for a number of years in field culture on Woodland Farm and they have been profitable, yielding sometimes nearly 30 bushels of beans per acre. We decide finally, however, that where one's soil is fitted for corn and alfalfa one will usually find greater profit in these than in soybeans in our latitude, except that it is desirable to have a supply of the beans for pushing forward pure-bred lambs. In Louisiana the beans were much more profitable than cowpeas and easier grown on alluvial soil. I have devoted a good deal of space to this legume because, while it is not strictly a meadow plant, it is assuming considerable importance at present, and is destined to come more and more into use in general farm practice, especially in the South. Interested readers should have Farmers' Bulletin 372, from which I quote:

Comparison of Soybeans and Cowpeas.—Inasmuch as the soybean is adapted to nearly the same place in the farm rotation as the cowpea, a comparison of the two plants is pertinent. The soybean is determinate in growth; that is, it reaches a definite size and matures. Nearly all varieties of cowpeas, on the other hand, are indeterminate, continuing growth until killed by frost. Soybeans, with the exception of a few varieties, do not vine, but grow erect or nearly erect. Cowpeas, on the other hand, are viny plants, and therefore more difficult to harvest. Soybeans mature all their pods at one time. Cowpeas continue to produce green pods as long as the plant lives. Soybeans will withstand quite heavy frosts, both in the spring, when young, and in the fall, when nearly mature, while the same frosts are fatal to cowpeas. Soybeans are more drouth resistant than cowpeas, and in a dry season will give much greater yields; they will also withstand excessive moisture much better. For green manuring or soil improving, the cowpea is far

more valuable than the soybean, as it will smother weeds much more successfully. The value of the hay of the two plants is nearly the same. There is frequently doubt as to which is the more desirable to grow. On relatively poor soil or when broadcasted cowpeas are always preferable. When cultivated, the soybean will yield the greater return, and if cut late the hay is more easily cured. For growing with corn or sorghum for hay or silage the cowpea is generally preferable to the soybean. The feeding value of an acre of soybeans for beef cattle was found by the Tennessee Experiment Station to be about 50 per cent greater than that of cowpeas grown on an adjoining acre. This was also approximately the difference in yield of the two crops. As a grain producer the soybean is in every way preferable to the cowpea, as it produces larger yields of richer grain and can be harvested much more easily. The soybean, therefore, is to be recommended above the cowpea where intensive rather than extensive farming is practicable and desirable.

SUMMARY.

For intensive farming the soybean is the best annual legume to grow for forage in the southern part of the cottonbelt and into the southern part of the cornbelt. The soybean, whether used as hay, grain, straw or silage, is very valuable as feed for live stock. Soybean hay is practically identical in feeding value with alfalfa and yields from 2 to 3 tons per acre. To make good soybean hay the crop must be cut when about half the pods are full grown or when the top leaves first begin to turn yellow. Soybean grain is more valuable than cottonseed-meal as a supplemental feed in the production of pork, mutton, wool, beef, milk and butter. A bushel of soybeans is at least twice as valuable for feed as a bushel of corn. As the grain is hard it is usually desirable to grind it into meal for feeding. This is best done by mixing with corn before the grinding to prevent gumming up the mill.

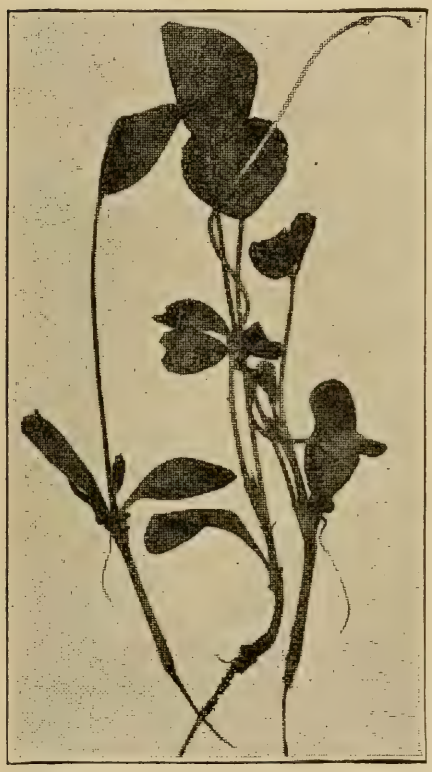
Harvesting ordinarily should be done when the leaves first begin to turn yellow, as the quality of the straw rapidly deteriorates thereafter and the yield of seed will be practically as large as at any later time. From 20 to 30 bushels of grain and 1½ to 2 tons of straw per acre are not uncommon. If soybeans are grown for the seed alone, and sometimes this is desirable, the harvesting can be done most easily by waiting until all the leaves have fallen. Soybean straw, if the crop is cut before the leaves fall, is fully as val-

uable for feeding as timothy hay for cattle, and is eaten by stock with much relish. Even when the harvesting is delayed until all the leaves have fallen, stock will eat the straw readily. Mixed with corn, soybeans are excellent for silage. The two crops may be grown together, but it is usually better practice to plant in separate fields and mix when putting into the silo. It is necessary to give the soil thorough preparation in order to be successful with soybeans. Only fresh seed or seed which has been tested for germination should be planted. Two-year-old seed is usually not reliable. The seed should be planted shallow, not to exceed 2″ in depth, and preferably in rows 30″ or, better, 36″ apart to permit sufficient cultivation to keep down weeds. For harvesting soybeans a mower with or without a side-delivery attachment, a self-rake reaper, or a self-binder can be used. A binder can be used only with the tall varieties. The thrashing can be done with a grain separator by using blank concaves and running the cylinder much slower than for small grains or by the use of machines specially designed for handling soybeans and cowpeas.

Soybeans and cowpeas can be grown together satisfactorily; the hay of such a mixture is better than either crop alone and the yield is generally greater. In planting the two together the seed should not be covered too deeply, as deep planting will result in a poor stand of soybeans. As a crop in a short rotation soybeans are very desirable. They can be grown so as to use an entire season in the case of the late varieties, or two crops in one season can be secured from some of the earlier ones. They can also be used very advantageously to follow a small-grain crop the same season. The important commercial varieties of soybeans are the Mammoth, the Hollybrook, and the Ito San. Among the most valuable new varieties are the Austin, the Wilson, the Riceland, the Meyer, and the Haberlandt."

Alfalfa or Lucerne (Medicago sativa).—I have purposely left the description of the best forage plant to the last. There is no clover, vetch, cowpea, soybean or grass, worth growing where alfalfa will grow well. Of all forage plants alfalfa is easily queen. It makes the greatest weight of forage during the year. The forage is richer than almost any other, and more palatable.

All animals thrive exceedingly eating alfalfa either green or dry. As the old Roman author put it, "It is good for all manner of famished cattle whatever." Alfalfa uses the whole of the soil, rooting deeply; it uses all of the season since it is hardy and endures frost. It re-



Young Alfalfa Plants Attacked by Dodder.

Mature Dodder Plant on an Alfalfa Stem.

quires sowing only once in several years. It enriches soils more than any other clover. It has many virtues and not one fault save that it will not grow on impoverished soils nor on sour, cold or wet soils. These very faults are made virtues because they cause men to

think and study their soils and become better farmers and better men. The truth is that any soil that will not grow alfalfa is seriously deficient, and when it has been so ameliorated that alfalfa thrives on it the soil is fit for any crop whatever, save that it may be too full of nitrogen to grow oats or other grains with soft straw.

Alfalfa is a strongly perennial clover-like legume, having a large deeply penetrating root and a top with many branching stems. It carries a small purple, greenish or yellow bloom, and the seeds are arranged in screw-like pods. It is a plant starting very early in spring and capable of yielding 2 to 6 or 8 crops in one year, 3 cuttings being commonly taken in Ohio, Illinois, Nebraska and Colorado, and more in regions to the southward.

History.—No one knows the origin of alfalfa. It came to Europe through the Persians and was highly esteemed by the ancients. It has long been cultivated in Europe under the name of "lucerne" and is today held in the highest esteem of any legume in France, Italy and some other countries with soil and climate adapted to its culture. Though it has been grown many centuries, it is only within recent years that it has been well understood, so that today its culture is being more rapidly extended in parts of Europe than ever before. I saw its introduction pushed in Denmark and listened with pleased interest to accounts of its virtues and needs, "that the soil be well drained, that it have lime enough and inoculation."

The Spanish people brought alfalfa to the New World from Chili; it came to California whence it spread to

Utah, Colorado, Kansas and the east. Our grandfathers grew it too in a small way, bringing seed from France and England, and some few spots, such as the limestone region about Onondaga Co., N. Y., grew it for many years, as did a few farmers in Virginia and elsewhere. Possibly I should state that I began growing alfalfa in Utah in 1886, and alfalfa seed was first sown on Woodland Farm the same year by my father. In 1900, convinced of its great worth, my brothers and I began growing it in a small way in Ohio on the farm on which we still reside. Since then I have studied the plant in many states and foreign countries, and may hope to have been helpful in getting it established on many farms that had not previously grown it.

Soil for Alfalfa Growing.—Alfalfa roots penetrate deep and forage wide. They refuse to grow in a wet soil and may die and root off if the soil fills with water for even a few days in hot weather. A dry soil, then, is the first requisite. Nevertheless, land not naturally dry may be made dry by drainage. On Woodland Farm are many acres growing very good alfalfa that had first to be drained by tiles. In tiling land where alfalfa is to be sown, one should dig trenches 3′ to 5′ deep wherever this is practicable. In truth, land drained to a less depth than 30″ had better be devoted to another more shallow-rooted legume. In Louisiana, however, I have seen very good alfalfa grown where the permanent water table was hardly more than 2′ down, but there the plant was treated almost as an annual; thriving at first, it became unthrifty after a year or as soon as its roots had reached the saturated subsoil. After a soil is dry,

next consider its lime content. Alfalfa loves carbonate of lime. So-called "natural alfalfa soils" are always soils heavily charged with carbonate of lime. The alfalfa-growing soils of Colorado, for example, contain from 1½ per cent to as much as 10 per cent or more of carbonate of lime. The same condition is met everywhere in the West. In southeast Missouri along the Mississippi River one finds alfalfa growing vigorously; one finds, too, a soil with about 1½ per cent of carbonate of lime. In Louisiana, on a very heavy, tenacious "buckshot" clay residue from the overflow of the Mississippi River, I found alfalfa thriving well, and analysis showed a lime content of about 1½ per cent or a little more. On Woodland Farm the subsoil is well filled with small limestone pebbles and the surface soil of the best alfalfa fields will effervesce when muriatic acid is poured onto the soil. A natural alfalfa-growing region is found in Alabama and Mississippi on the rotten limestone of the black prairie region. Onondaga Co., N. Y., is made up largely of limestone hills; there alfalfa thrives. In the parts of France having most lime in the soil one finds the most lucerne. In England it is grown where the soil is calcareous or lime-impregnated. I have nowhere found alfalfa growing profitably or well except on soils well filled with lime either by nature or by man.

Soils Can Be Made Fit to Grow Alfalfa.—The fact that alfalfa is a lime-loving plant would be discouraging were it not that its peculiar requirements are quite easily met if men will take trouble. For instance, there are hardly any soils less adapted naturally to alfalfa-growing than the sands of the Gulf Coast. These sands

are deficient in lime and in nearly all the mineral elements of fertility. In their natural state they would not nourish alfalfa well enough to keep it alive for one year. Alfalfa had always failed there until at last men learned of its lime hunger. Since then, by using sufficient carbonate of lime on these sandy soils, alfalfa-growing has been established, and as healthy alfalfa plants are now growing within sight of the blue waters of the Gulf of Mexico as can be found anywhere. If one wishes alfalfa anywhere one can have it if one is willing to pay the price, and the price is simply what it will cost to lime the soil well, preferably with unburned raw ground limestone or carbonate of lime, then to make the soil dry and fertile and sow seed with inoculation. Success is absolutely certain, given these conditions. What will all this cost? Is the game worth the candle?

It all depends on what one is trying to do, on one's ideals, agriculturally. It depends on the man, as well—whether he is a "first-rater" or content with things second best. It is easy enough, however, to estimate what it will cost to make land ready for alfalfa—land that is naturally very deficient. Experiments show that if one uses burned and fresh-slaked lime one will need from 2 to 4 tons to the acre. More than this might decrease the bacterial content of the soil enough to lessen the chance of a stand and crop. Less than 2 tons to the acre would not do the trick. If air-slaked lime is used, as much as 3 to 6 tons to the acre may be applied. If ground and unburned limestone can be had, and this is best of all, one may use as much as one chooses and the proper amount to satisfy will be found to be 4 to 10

tons per acre. Useful to most plants, it is simply indispensable to alfalfa. There is absolutely no doubt that the fresh ground limestone is safer and better than any other form of lime when one is using large amounts in the soil. I rejoice that recently many have been taught to believe in this, and doubtless this year has seen applied to fields destined to grow alfalfa at least 100,000 tons of carbonate of lime in the form of ground limestone, many using 4 tons to the acre, some using 6, some 8 and some 10 tons. Further, I have been able to induce manufacturers to make portable grinding machines that will go direct to the farm and grind into dust the limestone rocks that may be stored in the soil or strewn over it, and many of these machines are in use from Pennsylvania to Georgia. I have, then, a pretty fair knowledge of what it will cost to make into an alfalfa field land now unfit because of lack of lime. To buy ground limestone on cars in Illinois costs about 85 cents a ton—this where it is ground by the state with penitentiary convicts. In other states private capital is grinding it and selling it for around $1 to $1.25 per ton. When it is shipped and delivered to farms it costs commonly about $2 to $2.50 per ton. When the farmer grinds it himself and puts it on his soil from rocks that lay scattered over his pastures it costs less than $2 a ton, and some estimate it as low as $1.25. Further, when land is sweetened by the use of large amounts of ground limestone, it remains sweet for many years. Afterward application of an occasional dressing of a ton to the acre will ordinarily suffice in most regions to keep established alfalfa in a vigorous, profitable condition.

Where is Liming Needed?—There are a few areas in southeastern Kansas that need lime, and also in Iowa, though probably not very much of it. Much land in Missouri needs sweetening; all of southern Illinois and much of southern Indiana need it, and there are instances everywhere over Indiana where it would be beneficial, and from Indiana eastward one finds an increased lime-hunger in soils till one at last reaches the Atlantic Seaboard. Where it is not needed is where bits and fragments of limestone are found mixed through the soil, left there by glacial ice or by the breaking down of limestone rocks. Nearly the whole South needs carbonate of lime sadly, the exceptions being the alluvial prairie lands along the Mississippi, the Red, the Arkansas, and some other rivers, and the black prairie lands of Alabama and Mississippi. Liming is not commonly needed where red clover grows rank and tall, where bluegrass comes of itself and covers, although there are exceptions to that rule, and I have seen good bluegrass land that grew poor alfalfa till it was dressed with carbonate of lime, after which it grew splendid alfalfa, and the bluegrass too was greatly improved.

I make no apology for spending so much time in coupling alfalfa with lime and drainage because really if the reader had good enough drainage and plenty of carbonate of lime in his soil he would find alfalfa to grow so easily that he would not trouble to read this chapter at all. And yet there are other essentials; they are found in nature associated with soils calcareous and well drained, though when one is artificially making such a soil one may require to supply them.

Simple Test for Lime in Soils.—The old litmus paper test for sour soils is hardly conclusive to the alfalfa grower, since it does not tell enough. Alfalfa is not content with a soil that is simply neutral; it revels in a soil fairly alkaline with lime and there keeps its most perfect health. Fortunately the test for carbonate of lime is a simple one. Muriatic acid, a cheap chemical obtainable at any druggist's, when poured on soil having in it a large amount of carbonate of lime, will vigorously effervesce. The bubbles given off are bubbles of carbonic acid gas. If your alfalfa is sickly and yellow, if sorrel comes in and alfalfa goes out, test that land and the subsoil for effervescence. Ten to one you will find nowhere any of it. Then begin seeking a source of carbonate of lime cheap enough so that you can afford to use it in large amounts, or else forsake alfalfa for alsike clover and redtop.

Fertile Soils for Alfalfa.—Alfalfa also revels in a fertile soil. I have found no plant of use to men that does not like a fertile soil, but alfalfa more than most revels in sufficient plant food. It likes abundant potassium, phosphorus, some humus and much carbonate of lime. Withal, it is a famous soil-enricher; its nodule-bearing roots gather more free nitrogen from the air than those of almost any other legume, but it will not enrich very poor soils as well as will vetches, for example, or cowpeas. It likes a soil on which man has worked, although it finds in nature on the western plains soils that suit it to perfection. In the older eastern states it revels in rich, loamy, drained, sweet soils, full of humus, full of beneficent bacteria. I have often remarked

that in the East one could nearly predict whether alfalfa would thrive in a field or no by simply watching the plowman as he walked. If behind him blackbirds followed he might feel sure that alfalfa would succeed; if no blackbirds came he might well doubt. The blackbirds follow where there are earthworms. Earthworms are in soils drained and stored with vegetable matter. Where earthworms are bacteria also exist in myriads. If, then, that soil in which blackbirds feed has in it much carbonate of lime success with alfalfa is assured, if a few other easily-met requirements are obeyed. In short, make the soil dry, sweeten it with lime if you are farming on soil needing lime, make it rich, then sow alfalfa.

There are many ways of enriching land. In some places men grow crimson clover, fertilizing it well, which they turn under in spring and allow to decay to make humus to aid alfalfa-growing. Dairymen and stock feeders apply manure for a preceding crop, putting it on heavily; of this enough is left to cause the alfalfa to grow off vigorously. Any method of good farming whatever that will make the soil rich if it is not already so, will serve. I have found, however, that it is better if one can avoid turning under manure directly for alfalfa. If one could begin by manuring the land heavily, then grow corn or some crop that could be kept clean, give absolutely clean culture for a year, and then sow the alfalfa, one would avoid the curse of weeds. After all, no universal rule of soil culture will serve. On an old plantation in Louisiana, misused for 50 years or more, but of naturally rich alluvial soil, I sowed alfalfa.

The land would not grow more than 25 bushels of corn per acre and seemed very poor, hard and clayey. Wishing to make alfalfa succeed I cleaned out a stable that had in it 40 years' manure and enriched part of one field well. I used also commercial fertilizers, chiefly of phosphorus. Other parts of the land had no manuring whatever. The final result showed absolutely no difference in growth between the manured and the unmanured land—no sign of the fertilizer was discernible. The fact was, the soil was very rich in phosphorus and potassium. The alfalfa did not mind its deficiency in nitrogen, since the soil carried naturally the bacteria that alfalfa requires and as soon as it started to grow it gathered its own nitrogen. I have nowhere seen such a result elsewhere, and it is a safe rule to make soils destined to grow alfalfa as rich as one well can. Assuredly here I address my words to farmers in eastern America; dwellers in Idaho and Colorado may smile if they will, though in Nebraska manure gave good returns applied as preparation for alfalfa, as, also, it did in Iowa. Now, with rich land, drained, filled with carbonate of lime, are we ready to sow alfalfa? Nearly. Now comes inoculation. I know of no plant more dependent on its bacteria than alfalfa. Without them it is a poor, sickly, short-lived plant.

There are several ways of inoculating land for alfalfa, but first let us consider where it is needed. Assuredly not in California nor in any of the semi-arid land of the West; not, commonly, in Kansas now, though once it was needed; not often any more in Nebraska, but in all the region east of the Missouri River one is apt to

run against land destitute of the alfalfa bacteria. It is pretty safe to assume that if you have never grown alfalfa on your farm you will be helped by inoculation. If sweet clover grows naturally there you have the bacteria; they inhabit at pleasure either legume. If you have fed hay made from alfalfa meadows and used the manure you have inoculation; in fact, wherever you have used much manure of any sort the chances are that you have the bacteria. At the same time, I have seen very small and sickly alfalfa growing close to a barn where presumably much manure had been spilled, and search showed that there were no nodules on any of the alfalfa roots. In part this may have been the result of acidity of soil, since no lime had been used there. In the course of many years' study I have yet to find any soil full of carbonate of lime and highly manured that especially needed inoculation. However, the trick is of inestimable value on soils that need it, and many do, as there is an overwhelming wealth of experience to prove.

Alluvial soils commonly do not need inoculation. For example, in Louisiana there was no need of inoculation in the heavy "buckshot" soils, but in the sandy soils with less lime, inoculation was good. Inoculation is the life of alfalfa in eastern Virginia, in Maryland and, in truth, in most of the Atlantic Coast region. It is less seldom practiced in Ohio, but is strongly advised for New York. It is safe to do it wherever alfalfa is a new crop. On our own farm in Ohio we observe that we now commonly get a crop of hay the year it is sown, whereas in former years, while we got good stands, we got no hay till the second year.

How to Inoculate.—The safe way is by use of soil from either a successful alfalfa field or from a sweet clover patch. If it is near at hand load up the earth in a manure spreader, and just before sowing the seed distribute the soil lightly over the field, following the spreader close with a harrow that will mix the inoculating earth with the soil below so that the bacteria will not be hurt by the sunlight, which is commonly fatal to them. If one must purchase soil one can make it fine and mix 100 pounds with 20 pounds of seed and sow the two together, covering instantly. If the seed and soil are very well mixed together they may be sown with a drill. There are now made drills that sow alfalfa seed very well, putting it in at slight depth and affordiing nearly perfect opportunity for growth. One can dry inoculating material in the shade, make it fine by passing it through a sieve, wet the seed well and as soon as it has drained but not dried mix with it enough of the dry earth to make it sowable or drillable. This method requires very little earth and gives good inoculation.

Spring or Summer Seeding.—In Oklahoma spring seeding is commonly practiced because then farmers can have enough moisture to start the plants, while their falls are commonly dry as well as their midsummers. In Kansas the same conditions prevail more or less, though some midsummer and fall seeding is done there. In Iowa sowing after oats or early potatoes or on land that has been kept fallow during the early season gives good results, while, because of the weed-infested nature of the soil, spring seeding is not always successful. In Illinois much midsummer seeding is done, and some spring seed-

ing. In northern Ohio, where is located our experiment station, midsummer seeding seems best, while in central Ohio, where is Woodland Farm, spring seeding has always been most successful. It seems to be largely a matter of previous treatment of the soil; where land has been permitted to become very much infested with weeds it is hardly safe to sow alfalfa in spring until a course of cleansing has been given; where the land is fairly clean spring seeding is best. It also follows lime to a greater or less degree. For example, in the lime lands of Alabama men can often sow alfalfa in spring, midsummer or fall, while in most of the South only fall-seeding is safe, because of weeds and crabgrass. There is a steady increase in the call for seed during June, July and August so that now rather more than half what some seedsmen sell goes at this season, whereas once nearly all was sold in February, March and April.

Clean Land Essential to Spring Seeding.—I am sure that few farms could have shown more weeds in cornfields than once we grew on Woodland Farm. After we began growing alfalfa, however, and became desirous of having a clean seedbed for it, we learned to cultivate better and to clean out the cornfields with hoes after the corn was "laid by." The cost of this we found was not great, and we warred especially on redroot, lambsquarter and pigeongrass, or foxtail. All these are bad weeds in young alfalfa; the foxtail nearly kills it and is bad in old meadows as well. We had no hope that our efforts would result in more than lessening the weeds, but already we have found a marvelous change

in our fields. In this year's seeding (1910) there are many rods of alfalfa with not one weed nor one spear of foxtail grass, but only clean, healthy alfalfa, whereas in our neighborhood alfalfa is so overgrown with weeds that it is doubtful whether it will survive at all. We have learned one encouraging lesson; foxtail may readily be exterminated. It requires but one year's perfectly clean cultivation to accomplish this, as the seed will not lie dormant in the earth as will seeds of some other weeds. It pays, then, to keep the land clean where alfalfa is to be sown the following year.

Depth of Plowing.—In parts of the Old World men plow much more deeply than we do in America. In France it is common to plow 20″ deep for alfalfa. It has been our experience that, commonly, the deeper land is plowed for alfalfa the better the health and vigor of the plants, and the less danger from weeds. Soils vary, subsoils sometimes containing much more carbonate of lime than do surface soils above them. Where this condition obtains it pays to plow as deeply as one can. I have seen clean, vigorous, thrifty alfalfa on deep-plowed land and just alongside it poor, thriftless, weed-infested plants where it had been plowed shallow. On the other hand, there are doubtless soils where deep plowing would do no especial good. The new type of disk plow or "tilling machine" that uses two disks, both in one furrow, one under the other, promises to be a great aid to alfalfa-growing. Deep-plowed land will hold much more moisture than shallow-plowed, which is a decided advantage nearly everywhere, as there is seldom or never enough moisture in the soil throughout the season. As

a rule, then, plow for alfalfa as deep as you can, no matter how much raw, fresh earth you turn up. It is wise to leave strips for testing the result with ordinary plowing.

Seedbed for Alfalfa.—The plowing should be done some time before seeding time where this is convenient. It is necessary for it to be in some manner settled together. When seeding must follow plowing at short intervals, one can use the disk and other harrows freely to bring the earth firmly together again. A fine, firm seedbed is needed, made smooth enough so that one can seed to a uniform depth. If the alfalfa is to be irrigated the land must be carefully leveled also, so that the water may be led over it at no place too deep, yet all be covered.

Quantity of Seed to Sow.—Alfalfa seed of good quality commonly germinates well. When sown broadcast and covered with the drill or harrow if the seedbed is good 15 pounds of seed will give a thick stand. When the seed is drilled with special alfalfa drills so that each seed has proper depth of planting, 5 pounds or less gives a thick stand. Ordinarily as sown on rough ground and given unequal covering it is advisable to sow 20 pounds to the acre. The Ohio station secured the same yields from 5 and 25 pounds. The practice with us is to sow from 15 to 20 pounds. It does no harm to have a stand slightly too thick. Nature thins it soon enough. To sow 30 pounds to the acre seems sheer waste.

Nurse-Crop for Alfalfa.—With spring seeding east of the Missouri River a nurse-crop seems desirable. One gains the hay made from the nurse-crop and ordinarily does no injury to the stand. The nurse-crop in a measure

prevents growth of annual grasses and weeds. Beardless spring barley is by far the best nurse-crop, since it is not apt to lodge and draws less moisture from the soil than would oats. One bushel of barley to the acre is enough. Commonly it should be cut for hay, though if it stands well it may be allowed to ripen its seed. If oats are sown as a nurse-crop 3 pecks of good seed will be enough for an acre, and the crop must be mown for hay as early as bloom appears, else the stand of alfalfa will be greatly weakened or entirely destroyed. Long ago a farmer in New Jersey told of using winter rye as a nurse-crop, sowing it in the spring. We tried this with excellent results. The thrift of the alfalfa was better in the part of the field sown to rye than in any other part, and the stand was perfect. Winter rye sown in spring should not be allowed to form heads; it dies down when hot weather comes, and thus does its work without injury to the alfalfa.

Method of Sowing Alfalfa in Spring.—Our practice for many years has been to make the land ready by several diskings and harrowings, having it smooth by using last a plank drag. A common grain drill with a grass seeding attachment sows the barley, one bushel to the acre, and the alfalfa is sown ahead of the drill so that it is covered by the disks. Some of it is covered too deeply, but enough gets through to give a good stand. A plank drag is floated over the field to make a finishing touch, so that the mowers may run nicely there later in the season. Having all our land inoculated now, we give that matter no thought; were we to start in a new place we should first distribute the inoculating earth.

Fertilizer for Alfalfa.—The sooner alfalfa gets a vigorous start the better; therefore it is wise to fertilize it well as it is sown. We commonly use bonemeal or acid phosphate at the rate of 300 pounds per acre, though we have used "floats" or fine-ground raw phosphatic rock with good results, using of course more to the acre. In Virginia I have, by the way, seen better results come from 900 pounds of floats to the acre than grew on an adjoining plot where was applied 400 pounds of bonemeal. Sometimes we add a little potassium to the fertilizer, this on special soils needing that element. We do not use nitrogen on soils that are inoculated and think it more often harmful than helpful since it encourages weed growth.

Alfalfa Seed Drill.—A drill is on the market that will sow alfalfa seed at the proper depth, and several manufacturers are now working at the problem of making drills that will accurately place alfalfa seed as to depth and amount. Such drills should save much seed and give uniform stands. They can not work well unless the land is made very fine, smooth and level. In using such drills where a nurse-crop is desired, one can double-drill; that is, follow the grain drill with the alfalfa drill. In seeding later in the season where no nurse-crop is permissible the alfalfa drill finds its almost undisputed field.

Summer Care of Spring-Sown Alfalfa.—When the little alfalfa plants are six weeks old and 5″ high they will be found to be inoculated and to have nodules attached to their roots. Your sole care will be to keep off of the field and keep all animals off. Should coarse weeds ap-

pear they may be pulled by hand. Carefully avoid clipping or cutting the alfalfa until it has sent out from the base of the stems, at the crown, small shoots or suckers that are about to make new stems. When these shoots come the alfalfa needs cutting without much regard to how large it is or whether it happens to be in bloom or no. If it is mown off the first season before these shoots appear it may be destroyed. In truth the rule holds good during the life of the plant that it should not be mown off before the shoots appear; after the first year it will not die if mown too soon but it will be markedly weakened. Let it alone, then, till it is ready to cut; then cut it off with its accompanying nurse-crop and make into hay. Ordinarily there will follow another growth that will be made into hay in about 40 days.

Fall Care of New-Sown Alfalfa.—I admit that I am writing this chiefly for the help of men living out of the recognized alfalfa-growing districts. In Utah it did not much matter what one did to alfalfa; it came serenely forward the next year just the same, and this is true of Idaho, Colorado and other western states. In all the eastern country, however, it pays well to send alfalfa into winter with a growth standing of at least 12″. Therefore we avoid late cutting and never in the East pasture in the fall, unless we desire to destroy the alfalfa and plow it up. Bear this well in mind: Land well inoculated can safely be seeded in the spring, as the vigorous alfalfa gets ahead of the weeds.

Summer and Fall-Seeding of Alfalfa.—Commonly men sow alfalfa seed in late summer or early fall. The reason for this is that their soils are thoroughly well

seeded with weeds and foxtail grass, so that they do not dare sow in the spring. There are certain rather rigid requirements that must be met if one is to sow in the summer or fall. First, manage to get a good seed-bed, fine, firm, moist and deep. He may slight his seed-bed somewhat in early April, but he must make it very perfect indeed if he sows in July, August or September, as the hot suns of the summer soon take out the moisture and leave the seeds to perish. The ways most commonly adopted for midsummer seeding are to plow in the spring and afterward give weekly harrowings to retain moisture till mid-July, by which means also one will destroy most of the weed seeds that lie near the surface; or, sow the land to barley, oats or wheat, cut off the crop either for grain or for hay and at once plow the land and prepare the seedbed for alfalfa; or, plant early potatoes, as early as possible in the spring, enrich the land well where they are and dig as soon as possible, then immediately prepare the land and sow to alfalfa. The latter plan works well where one wishes to grow potatoes. The heavy fertilization needed for the crop, and the frequent cultivation during the season of its growth, together with the cultivation given by digging, leave the land in good order for alfalfa. When one plows a stubble to sow to alfalfa one should take all possible care to avoid loss of moisture. The best method is to harrow and make fine each morning and afternoon what is plowed during the half day. One may plow till 10 o'clock, then harrow on the strip till noon, plow again till 4 o'clock and harrow till 6. The use of the roller will also aid in conserving moisture at this time.

One can not safely sow alfalfa seed in the dust. There is danger that there may come a shower sufficient to make the seed germinate, but not sufficient to wet the underlying dust. The result would be that the little seedling would perish before its rootlets could reach soil moisture below. One must wait till the earth is moist clear down before sowing the seed, or take chances. After a good rain, as soon as the soil is fit to work, harrow to loosen the surface and then drill in the seed. No nurse-crop is needed or permissible in fall or midsummer seeding of alfalfa. North of Tennessee one should sow as early as possible after the middle of July. Alfalfa is in no sense a plant like wheat or rye or timothy grass, liking to be sown in the fall. It must get a strong root before cold weather or it will likely perish.

Making a Seedbed in the South.—In Louisiana I had direction of a demonstration farm on an old abandoned cotton plantation. The soil was the so-called "buckshot," that is, a dense clay made by a deposit of still flowing water of the Mississippi River, rich in lime, rich in phosphorus and potassium but very deficient in vegetable matter and nitrogen. The land was level and wet, being flooded by each heavy rainstorm. Previous attempts at alfalfa-growing had commonly resulted in failure, though the manager had established one thrifty field on slightly sloping ground. The first successful step in getting alfalfa there was to plow the land 10″ deep in July, throwing it into ridges 2 rods wide and as high in the centers as we could raise it. The middle furrows were cleaned out with a road grader so as to give perfect drainage. When we had the land ridged, the rounded ridges re-

sembled well-graded roads; the summit of each ridge was about 2′ above the furrow. The land being immensely hard, broke up in great lumps and clods. These we made no effort to subdue, as they were quite hopeless. When rain came at last the clods melted, then the disk and other harrows were used and the land made into a fine seedbed. In September, weather and soil conditions were right, and the seed was sown. It came up well and made a good growth before cold weather. The following year each of the fields made fine harvests of hay, probably the best that had ever been grown in the Mississippi bottoms in Louisiana. These buckshot soils needing no inoculation, none was given. I mention this instance to point a lesson. The preparation for alfalfa went on up to seeding time. All the land that was plowed early made good alfalfa, the first plowed lands the best. From this degree of value there was steady deterioration, till at last there was complete failure. The early-prepared land is the winner with alfalfa sowing, since one can not in late plowings often get a fine, moist, firm seedbed.

Do Not Clip Seedings of Alfalfa.—Nothing is to be done with late-seeded alfalfa except to leave it alone. If one can stimulate it by fertilization at the time of seeding to make rapid growth well and good; one can help it no more after the seed is sown in the ground. Neither clip, pasture nor even let an animal set foot on it again till warm weather in spring. The one thing that one may do in the North is to go over it with the manure spreader after the land freezes and sprinkle it with manure—enough to prevent the frequent freezing and thaw-

ing of the land, but not enough to smother the little alfalfa. Light, chaffy, strawy manure is better here than heavy material.

Treatment and Use of Alfalfa Meadows.—If one's land is deficient in phosphorus (and whose is not east of the Missouri River?) one should in the spring go over the alfalfa meadow with a fertilizer distributor and leave there a good dressing of some phosphatic fertilizer. Various substances are available; basic slag, which has in it much lime and available phosphorus, is a good thing to use near the seaboard where it is cheap. Freights to the Middle West make it impracticable to use it there. Acid phosphate is everywhere available and is so soluble that it is perhaps the best substance for mere top-dressing. Bonemeal is always good and can be got into the soil by disking or by use of the spring-tooth harrow. One can apply raw phosphatic rock or floats, though it is not available unless mixed through the soil, and will need to be well dug in with spring-tooth or disk harrow. We seem to keep up the production of our alfalfa meadows by using 300 pounds to the acre of acid phosphate of as high analysis as we can buy. Next let the alfalfa alone. It injures it to walk through it or drive through it. Rust is its bane in the East; wherever it is disturbed this rust starts and from that point it spreads. I have seen alfalfa destroyed in a strip 20′ wide along a footpath made by fishermen near a creek; it is injured where teams turn in cultivating corn. Let it be till it is ready to be mown.

Time to Mow Alfalfa.—When you suspect, finally, that the alfalfa is ready to be made into hay, go to the

field and, getting on your knees, make close examination to see the condition of the small shoots near the ground. If these have not yet started at all, delay a little until they do start, no matter if it is in bloom. When the shoots are an inch or two long, cut and make into hay, no matter how much or how little bloom there may be. The stage of bloom is no certain index of proper time to cut alfalfa in the East, if it is anywhere. The shoots at the base of the stems are unfailing as telling the internal condition of the plant, its vigor and readiness to send out new and vigorous growth. If one lets it stand long after these shoots appear, one will be in danger of cutting them off, and the leaves will have fallen from the stems, leaving very hard, woody hay. I. D. O'Donnell of the Yellowstone Valley cuts down 400 acres at one dash when the right time arrives, so as to keep his alfalfa always in full vigor.

Making Alfalfa Hay.—The making of alfalfa hay is an art seldom learned. Most men are content to allow the sun to dry the stuff till it is crisp and brittle, then rake it, leaving the earth green with leaves, the best part of the hay lost. Alfalfa leaves have been proved by the Nebraska station to be worth pound for pound a little more than wheat middlings, so it is clear that one can not afford to leave them scattered over the field. The right method is to rake the hay while it is yet tough enough to hold its leaves, making the windrows small so that it may go on drying somewhat in that condition. Afterward it may be laid up in small cocks, laid high enough to put enough hay together so that a rain will not penetrate through, and narrow enough to let

the air do a good deal of drying. In these cocks the hay will often finish its drying perfectly. Often it is wise to open them during the heat of the next day after cocking, and let them lie in about six flakes exposed for a time to sun and air. If very damp it may be turned once and then hurried into the barn or rick. It must not be allowed to remain in the cock too long, else the alfalfa below will turn white. This method is cheaper than it sounds; men trained to the work will cock hay astonishingly fast and once in the cock it defies most weathers, especially if cocked green, as advised, because then the stems droop so as to turn off water from the clouds.

Use of Hayloaders.—Because labor is so hard to get, men find the hayloader a profitable help. It is not so safe to use with alfalfa as with other hays, but if used intelligently little loss may follow. One should have a side-delivery rake, turning the hay over lightly and loosely, into long, smallish windrows; then after they have sunned somewhat more, follow with the hayloader and with no great loss put the hay on the wagon.

How Dry Must Alfalfa Hay Be?—If one is placing only two or three tons in a mow one must have the hay dry, else there will be often a disagreeable dusty mould appear. If one is placing 50 tons, more or less, together, one can have it more moist, since the heat evolved in curing will destroy the mould germs. Our test is to take a wisp of the dampest of the hay and twist it as hard as we can. If moisture exudes, the hay will likely spoil in the mow; so we dry it further before storing. If no moisture can be seen, even though it feels tough, we

hasten it to the mow. In general, we try to get the hay as dry as we can before housing. We seldom make in Ohio any alfalfa hay of the bright green color so commonly seen in the West; but we find that animals relish the brown hay as well as the green, and perhaps relish it more.

Value of Alfalfa Hay.—There are three principal hay plants in the United States; timothy, red clover and alfalfa. At present there is probably a good deal more alfalfa grown than red clover, since in 1899 the production of each was about the same, though of red clover the acreage reported by the 12th census was about double for clover what it was for alfalfa. The production stood: alfalfa, 2.5 tons per acre; red clover, 1.3 tons; cultivated grasses (mainly timothy), 1.1 tons. Since then alfalfa has made great advance. It has passed the experimental stage; there are now no serious problems of alfalfa-growing to be solved, and men are sowing it more largely than ever before, while at the same time the demand for the hay increases faster than the production. For all classes of animals it is the best forage that can be grown in America, and at the same time it is the most efficient soil-enricher. Spillman reports that in Nebraska alfalfa has increased the yield of corn grown on sod 75 per cent. In Ohio we have repeatedly grown 100 bushels of corn per acre and more on alfalfa sod. The same land would have produced about 60 bushels before it had been sown to alfalfa. In Idaho wheat has increased in yield from 25 to 75 bushels per acre after alfalfa. In California orange groves 25 years old show markedly where alfalfa once stood, the portion of

the orchard on alfalfa sod producing one-third more, and the trees being larger and thriftier, and this despite the fact that the trees not on alfalfa land were given the more fertilizer. In Colorado on alfalfa sod more than 1,000 bushels of potatoes have been grown, and 113 bushels of wheat on one acre. In Ohio it is not well to sow oats after alfalfa, since they will lodge, but corn reveling in fertility finds none too much where the alfalfa grew. On the other hand, it is conceivable that continual growing of alfalfa and taking off of all the hay, returning neither phosphorus nor potassium to the land, might result, after a time, in a most serious diminution of mineral-element fertility; therefore it is wise in all the eastern states steadily to add to the phosphorus supply of alfalfa soils and to attend to the need of potassium if any need there be. Rightly managed, an alfalfa field is a mine of fertility by which little by little a farm may be redeemed and made rich. If the hay is fed or pastured, if the manure is returned and phosphorus is bought as needed, there should be small difficulty in doubling the productiveness of the average farm.

Feeding Value of Alfalfa Hay.—Alfalfa hay, cut at the right time, has about the same nutritive value as oats. It is rich enough so that it can be made into bread and fed to men; in truth, this has been done. It is a feed especially rich in protein, that material that makes the red flesh and blood, milk and brain and nerve tissue in the body. It has too much protein, in fact, for its fats and carbohydrates. Thus alfalfa hay alone is an unbalanced ration. I have been amused to see horses and mules running in yards with stacks of alfalfa hay

and stacks of bright straw going from one stack to the other and eating alternately, balancing their own rations in that way. It is clear that the great value of alfalfa hay is as a feed for milking animals, for young and growing animals, and as a part of the ration for working horses. The natural complement of alfalfa is corn, since that is rich in fat and starch and poor in protein. Working horses fed alfalfa hay in moderation maintain splendid flesh and work well and are enduring. Corn fed with alfalfa hay better balances the ration than oats. Horses should never be overfed with alfalfa, since they will eat it as long as they can reach it. Idle horses may become "soft" or of poor endurance when overfed on alfalfa hay, because it taxes the eliminative organs. Working horses accustomed to it endure fatigue well and have good wind.

In the dairy alfalfa very nearly takes the place of wheat bran. Some experiments place alfalfa meal as high as wheat bran for milk production; other experiments indicate that it is not quite so good. The Tennessee station found that with ordinary alfalfa hay 1½ pounds of hay equaled a pound of bran. It is very noticeable that cows fed alfalfa hay have a better look and weigh more than cows fed other hay with more grain. Its use seems to keep them in especially good health.

Alfalfa for Sheep.—Alfalfa is the natural feed of sheep. Millions of sheep are wintered on alfalfa hay in the United States, and many thousands of lambs are fattened on it. It is not profitable to fatten any stock on alfalfa alone if grain can be procured, since alfalfa is too bulky and one-sided in its composition to form a

perfect ration. Barley or corn fed with alfalfa make perfect lambs. For a maintenance ration the alfalfa alone will serve well, though even here bright straw, cornstalks or wild hay may be fed in connection with good results.

Alfalfa for Swine.—Hogs will eat a good deal of alfalfa hay during winter to their great good and health. If meant for hogs alfalfa hay should be early cut and nicely cured. It may be chopped fine and cornmeal mixed with it; it may be fed as one would feed it to cattle, or it may be ground into meal. The relative profit of either practice depends on the cost of alfalfa hay. Ordinarily it is cheaper to waste a portion of the hay (which works into the manure) than to go to the expense of grinding. For brood sows in winter alfalfa hay is almost indispensable. Always, when feeding swine on alfalfa, a partial ration of grain should be fed.

Use of Alfalfa Pasture.—Alfalfa sown for pasture should always be mixed with grasses, unless it is to be merely grazed by horses and swine. The grasses usable for this purpose are timothy, orchard grass and brome grass. Brome grass seems best for the purpose, but in time it will encroach on alfalfa and may weaken it. It yields the most and best pasturage, however. There is little danger of animals bloating on alfalfa pasture well mixed with grasses. Bloating is the one thing most to be feared in cows and sheep; horses and pigs seldom give any trouble of this kind. There are certain rules that, when observed, will commonly prevent bloating. Animals should not be turned on alfalfa until it has reached a good height and come nearly to bloom; it should be at

least a foot or more high. The animals should be filled as full as possible with green grass or some feed that they like. They should be turned in at about 10 o'clock in the morning and afterward left always on the field, not being taken off at night or during rains. It is when animals have been away from the field and become hungry that they eat too rapidly on return and are troubled by bloating. For the good of the pasture it should be so wide that it would never be eaten close, but once or twice a year the mower should go over the parts not eaten and the cut forage made into hay. Thus treated, alfalfa is little injured by being pastured. Always, in frosty countries, all animals should be taken from the field before time of very hard frosts, and no foot should afterward tread upon it until growing weather of the following year. Not only is it bad for alfalfa to be trodden upon in cold weather (except in the arid West), but it is injurious to animals to eat frosted alfalfa. Furthermore, alfalfa is better to have left on it a growth of at least a foot in height.

Alfalfa as a Soiling Crop.—Should one wish to get the utmost from one's soil, and be willing to perform the needed labor, one should sow alfalfa and feed animals by soiling. An acre of moderately good alfalfa will yield during the season from 20,000 to 30,000 pounds of green forage. A cow will consume, it is estimated, about 30 pounds a day of alfalfa with access to some other feeds, grasses and perhaps a morsel of dry corn. Thus a cow would in a month consume about 900 to 1,000 pounds of alfalfa forage, the acre keeping 25 to 30 cows for a month. In cutting alfalfa for soiling one should manage

to cut it as near as one can in regular rotation at the right time, keeping watch of the upspringing of the little shoots at the base of the stems, since to cut it before these start will decrease the second cutting. Once started right, one can mow off a certain area each day and thus keep it all in full vigor. It is better for alfalfa to be allowed to stand a few days too long than to be cut off too soon. The best way to soil cows is to have near the alfalfa field a pasture of bluegrass, brome grass or some other good pasture grass with large movable racks into which the green forage may be put. Thus the animals may largely balance their rations as nature suggests to them. Thus, also, the pasture is fed by the droppings of the animals, and by frequent changes of location with the racks no manure will ever be hauled. I have fed beef cattle in this manner with fine results. They had also a daily ration of ears of corn.

How Many Cuttings of Alfalfa?—Depending on the latitude, from 2 to 6 or more cuttings are taken in the United States. I believe, however, that alfalfa is often cut too frequently and that in our latitude on the 40th parallel (running through Columbus, O., Indianapolis, Ind., and northern Missouri and the border between Kansas and Nebraska) it is really better to cut three times than oftener. Commonly alfalfa here will be ready to cut by June 1, and again by July 10; afterward it does not come on so rapidly, unless the season proves very favorable. The third cutting will be delayed till about the last of August. Delays in doing the work caused by unfavorable weather may prolong these dates considerably. I should never cut alfalfa in our latitude in Oc-

tober, unless I wished to weaken the roots. However, if one can do the work promptly, one can take off 4 cuttings, and we have frequently done so, but 3 are nearer the average, and it will not always be ready to cut by June. In the South it may in the Gulf States be ready to cut in March or April, and then of course one can hardly avoid cutting it 5, 6 or more times.

Alfalfa Must Be Mown to Invigorate It.—In humid lands alfalfa will not live long unless it is periodically cut. After it has grown a little while it ceases to be vigorous, the leaves begin to fall and it is at a standstill until it is mown; after which it at once starts into vigorous growth again. Sometimes when it is time to cut alfalfa the growth may be insignificant, and one not knowing the habit of the plant might neglect to cut it, thinking it not worth while. The truth is, however, it will hardly start into growth at all until it is cut off. I have mowed off in late July a short growth of alfalfa plants hardly worth the raking, and had at once a vigorous growth start up that made much more than a ton to the acre in 40 days. The reason for all this is a mystery past finding out, but let the reader impress here upon his memory once and forever that alfalfa should never be cut before the shoots at the base of the stems have indicated that it is ready, nor ever let it stand past their coming or about 40 days' growth, no matter if it is no more than 6″ high.

As I write this we have a field of 40 acres of perfectly healthy alfalfa sown in April (it is now August) that has been once cut with the barley nurse-crop, is now no more than 6″ to 8″ tall and is beginning to bloom. It

has set the buds at the base of the stems, too, and must be mown off or it will make little more growth this year; so, though it is a disappointment not to get our customary crop of hay the year of sowing, we shall start the mowers soon and cut it as close to the earth as we can, knowing that it will at once start out vigorously and thus make strong root for winter. Though it might make a good hay crop in late September, we shall hardly cut it then, depending on its yielding us next year all the more for having been treated generously this.

How Long Does Alfalfa Endure?—I have seen alfalfa fields that had endured in good thrift for 40 years or more. These fields were in the Southwest, on rich, deep, dry soil where alfalfa roots could penetrate for 30′ or more. The stand was thin, but each plant was like a small tree stump, and the roots like great gnarled stubs of oak fully 2″ to 3″ in diameter. Such facts as these have led men to teach that alfalfa will endure forever. In eastern soils and under an eastern climate it will do no such thing. It is commonly at its best the second or third year after sowing, and then declines steadily in health and productiveness. To get the most good from growing alfalfa one should plow it up before it gets thin and is displaced by grasses. We commonly let it stand three or four years; though our practice was to leave it much longer, we now see the greater profit in plowing the field as soon as it begins to decline, not trying to resow or nurse it, but planting to corn, manuring the land for corn a second year, then resowing to alfalfa again. Thus managed, we keep our soil always at near the height of its production.

Inoculating in Expectation of Sowing.—I have given much space to the subject of alfalfa because it has engrossed my thought for many years, and because it seems to me assured that good farmers everywhere will desire to grow it. A man, for example, sufficiently liberal to possess and read this book is almost sure to desire to grow alfalfa. It is well for him to begin to get inoculation into his soil in advance of the time when he will sow alfalfa. This he can do by simply sowing alfalfa seed with his red clover each spring. He should first make the land dry enough for clover and alfalfa. If it is sour lime it; afterward he may simply mix in say 10 pounds of alfalfa seed with each 100 pounds of clover seed sown and sow the clover, preferably in April, by harrowing the land and covering the seed. Thus sown a fine sprinkling of alfalfa all over the land will result, and nature will attend to the inoculation, so that in a few years when he is ready to sow to alfalfa alone, the land will be ready for it. The growth of alfalfa will also be a good index to the state of preparedness of the land.

Varieties of Alfalfa.—There are innumerable varieties of alfalfa, but only a few have been isolated, and the seed is on the market. At present there is more use in getting seed from certain regions than there is in seeking special varieties. For example, seed from France thrives in the central states; seed from Algeria (imported through France) is not hardy. Seed from Kansas, Nebraska and Montana is hardy all over the eastern and central states, and is the best supply available now. Seed from Arizona is not hardy in Nebraska, but thrives

in Louisiana. There are also special varieties adapted to special areas. Among these are the new varieties brought from Siberia by Prof. N. E. Hansen, the Turkestan variety brought earlier by him and now in use in the drier parts of the cold Northwest, and the so-called "Grimm" alfalfa, which first came to our notice as grown by German farmers in Minnesota. This Grimm alfalfa is especially hardy and productive and adapted to the lands and climates of the Dakotas, parts of Montana and the British provinces.

Irrigation of Alfalfa.—One can get at the groundwork of the science of irrigating alfalfa if one will consider certain basal truths. First, alfalfa revels in moist soil and dies in wet soil; next, standing water on alfalfa in hot weather soon scalds the crowns and kills it; then, alfalfa covered with ice in winter is destroyed. Where it is practical, the best system of irrigating alfalfa is by the furrow method. In this method furrows rather deep and sharply defined are made across the field, running right down the slopes, as a usual thing, and near enough together so that the water will "sub" or soak through from side to side. After the seed is sown (commonly this is done before making the furrows, which are made by special machines built for the purpose that open 4 or more furrows at one time) one turns in water which is allowed to flow in very gentle streams down the furrows till the soil is thoroughly soaked, and the seed germinated and above ground. Afterward, the alfalfa is watered several times as it may seem to need feed during the summer. In the second year there will be small danger of washing, and large streams may be turned

out on the highest points along the head ditch and allowed to spread and flood over all the ground.

The second system is by the contour or check plan. Here little levees of earth are raised across the field, each one on a contour or level line and each one so placed that it will back the water up to the foot of the contour above. By means of these contours the field is made into a series of shallow ponds and all the surface is covered. This is the almost universal plan followed in Mexico and California. It is adapted to very level land. The furrow system applies to land having a strong slope. Once alfalfa is established and water is available, the thought is to keep it wet enough to have it growing vigorously, and not wet enough to scald it or drown it. Soils that are open, gravelly and pervious are best for irrigating, since they can not be filled with water to the point of drowning the roots. When water is abundant one can get more crops than if it is scanty. It is well to irrigate just before cutting and again within a week afterward. To put water on quickly and take it off quickly is the safe rule, but one must be governed by the permeability of the soil. In winter time in arid regions one must see to it that the soil is moist, else one's alfalfa will winterkill.

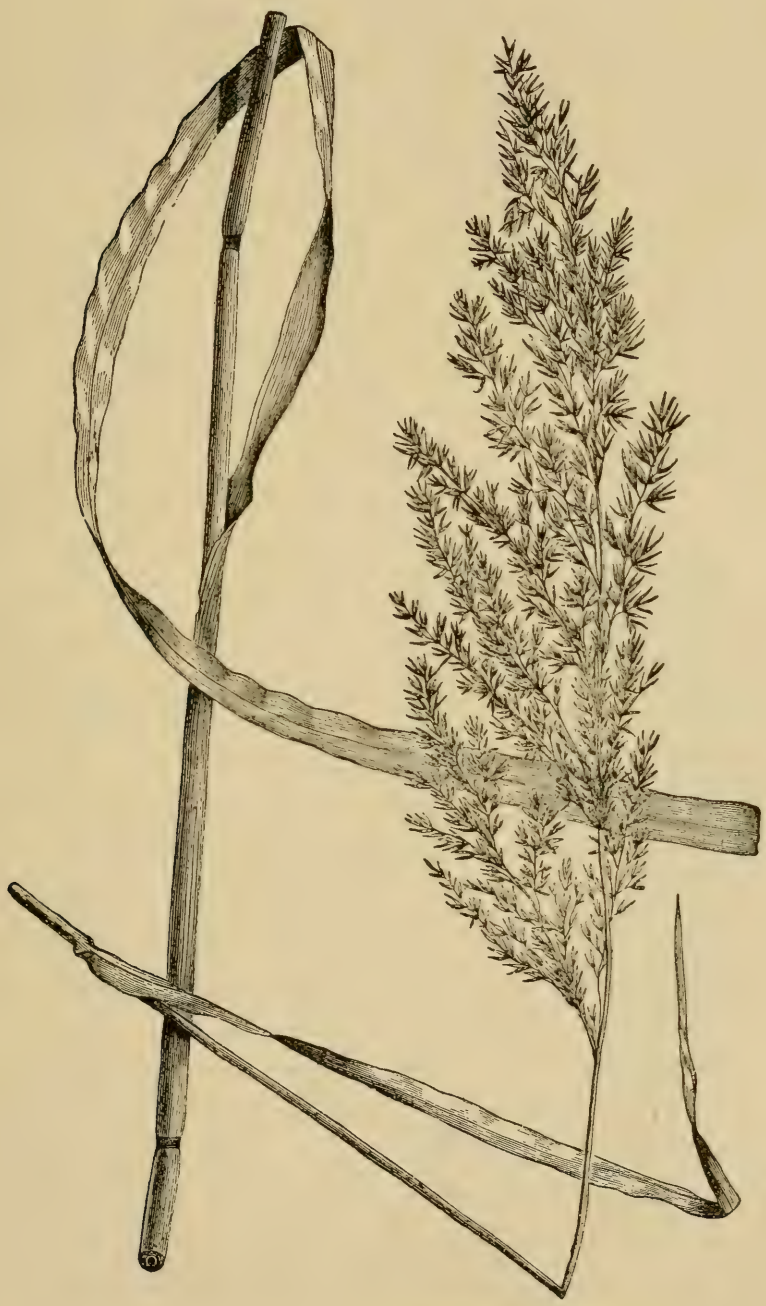
"Alfalfa Farming in America."—There are many points that the reader should know about alfalfa-growing —so many that I worked for several years putting them into a book with the title quoted. Interested readers are referred to that book for further details, since to give more space here to this queen of meadow plants would be to neglect its first plan; that is, to give a com-

prehensive account of the care of meadows and pastures, most of which are not today of alfalfa.

Meadow foxtail (*Alopecurus pratensis L.*)—This grass is closely related to timothy, for which it may be mistaken, although it blooms fully a month earlier, its stems are not so tall, its heads are shorter and more ovoid. According to Hunt, meadow foxtail makes a good sod in its proper habitat. Stems are few, 1′ to 3′ high, and sparingly furnished with leaves. The leaves are broad, long, thin, and grow rapidly when cut or eaten by live stock. Seed is sparingly produced and therefore expensive. It is generally of poor vitality and hence a good stand is seldom obtained, at least in America. The number of seeds per pound is 1,216,000. All commercial seed is imported.

Lamson says: "It grows naturally on rather superior soils of medium texture, and constitutes the greater portion of many of the richer, natural pastures of Britain. It requires two or three years after sowing to arrive at full maturity and, therefore, it is not suitable for alternate husbandry." Hackel states that it is especially adapted to wet meadows. Meadow foxtail is distinctly a pasture grass, being one of the earliest grasses to start in the spring. On rich soils it may be tried in mixtures for permanent pastures at the rate of 1 pound of seed to the acre.

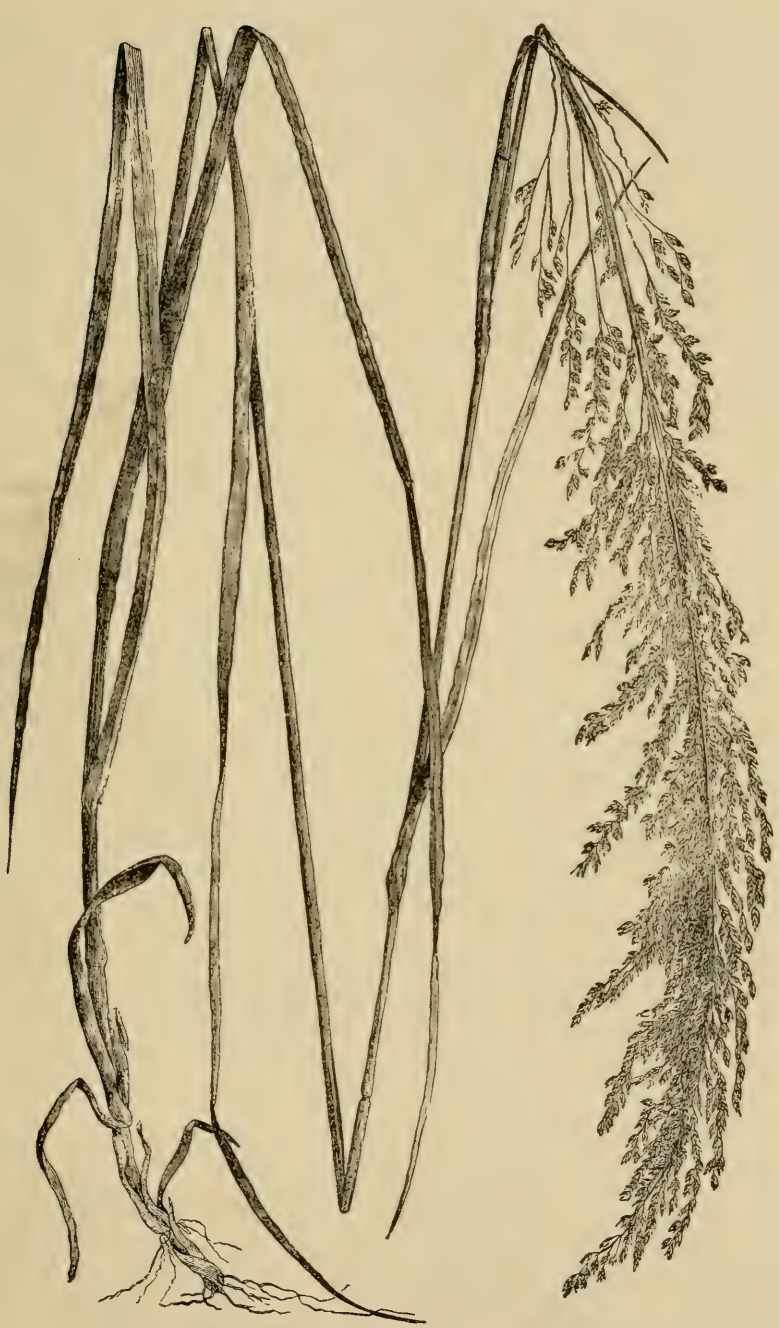
Blue Joint (Calamagrostis Canadensis).—Once much of the open land of eastern America was more or less covered with this fine, tall, nutritious grass. It made the typical grass of the moister regions of eastern America extending well up into Canada. It made a



Bluejoint Grass (Deyenxia—Calamagrostis—Canadensis).

dense, tough sod hard to break and where it grew great crops followed. It is now seen occasionally in moist places or by roadsides. It grows frequently 6′ high and if cut early makes hay superior to timothy. The yield is very good and the grass is permanent. I should expect a well-set meadow of this grass to mow 3 tons or more to the acre. It is well worth cultivating except that the seed are small and not easy to get, and the grass is slowly established. For permanent meadow in moist land inclined to be wet I know of no better grass than this.

Fowl Meadow Grass (Poa serotina).—This is a typical New England grass and is in use in low meadows in Massachusetts and other eastern states. Prof. Beal says: "It flowers about the same time as timothy. It makes a soft, pliable hay of excellent quality. The stems in damp weather branch at the lower joints and thus the grass is inclined to spread. On account of the large top and the slender stem this grass when sown alone is rather inclined to lodge. This is one reason for growing it with stiffer grasses, such as redtop. Like *Poa compressa,* or wire grass, it flowers rather late, has a dark green stem which remains green and nutritious a long time after the plant has gone to seed. It does not spread by rootstalks like bluegrass. It may be mown late and will yet make nutritious hay." This grass has not made progress elsewhere than in New England. It is somewhat difficult to get good seed. It will endure being overflowed more than other grasses. A Vermont station bulletin says: "It is one of the most valuable of our native grasses, being especially adapted to wet, overflowed intervale land where the usual hay grasses and



Fowl Meadow Grass (Poa Serotina).

clovers are liable to be killed by standing water. Redtop and alsike clover are capable of enduring a wetter soil than timothy and red clover, but fowl meadow grass will thrive best in soil where even redtop and alsike soon kill out. There are many acres in Vermont now occupied by sedges and rushes where fowl meadow grass would grow well if introduced. Seedsmen do not carry good seeds of this grass but it may be easily harvested from the wild grass in almost any town in Vermont, provided one knows the grass when one sees it."

CARE OF MEADOWS AND PASTURES.

"Now the blades of grass thrust keenly through the soil, burnished and glistening. It is as if spring marched into the land with an army with banners. Grass is the most common and least salient of the phases of nature. It does not lift itself into the vision like the forest. It does not offer an everchanging panorama like the sky. It has no dramatic violence like the sea. Yet nothing gives a deeper sense of the overwhelming power of nature than the silent upgushing of this rich, spreading tide of green. The power that swings the suns in a leash is not mightier than this which slowly and secretly urges the grass into the upper air. Indeed, is it not the same power? There is not a nobler symbol in nature of the mystery of renewal, the mystery of life, than the coming of the grass. To find a nobler we must look into the soul of man. Only there in its struggle, through failure and unconquerable aspiration, toward perfection does the great mystery take on a loftier beauty."

TREATMENT OF MEADOWS AND PASTURES.

Adequately to treat the subject of making a soil right and seeding it to clovers and grasses, then caring for the plants after I had them, would fill a farm library, so one can do little at getting it all into the space left in this

book. We must make a beginning somewhere, however, so here at the soil is a good place to set in.

Give the Meadow Your Best Soil.—One can till a rather infertile and hard soil and get fair returns from it because by tillage one can hold its moisture and liberate all the plant food there is; but when one seeds it down to meadow or pasture the tillage ceases, commonly, and there is no way of conserving moisture or creating it unless irrigation is available. It pays well to farm in this way; to till land as thoroughly as one can, steadily draining and enriching and getting it into the highest state of productivity, all with the one thought toward a final end—to get it at last laid down in meadow or pasture. There is absolutely no doubt that the greatest profit can come from the meadow some day, when things have been made right and the grasses and clovers are at home. Corn, prodigious though it is, will yield less of food for beast, and, by transfusion, for man, than will alfalfa. Many an acre of Virginia bluegrass is producing more beef or mutton or horseflesh than the average acre of Illinois could possibly produce. In the Old World men recognize this truth and lay down to permanent grass or meadows of a few years their best land, meantime keeping under the plow lands not strong enough to be profitable under other treatment. True, there are lands too rough, steep, rocky or infertile for cultivation, and these may be laid down to permanent pasture or devoted to forestry, or a combination of the two secured, and from such land profit may come; yet in the laying down to grass of the best lands will come the greatest profits. Furthermore, the men who steadily

plan their farm practices toward fulfillment of a scheme that will end in increasingly large areas of meadow and pasture in the height of productivity, and feed to profitable types of animals, will always be the men who will steadily grow richer along with their grassy fields, and will be recognized, too, wherever they may be, as men of substance and reliability, pillars in society and leaders in their counties. There are curious psychological reasons for this that we have not time now to consider.

Getting Land Ready for Grass.—I hope I may be permitted here to use the word "grass" in the farmer's acceptance of the term to include grasses and clovers grown in meadow or pasture, since it will be convenient so to use it, and I have good scriptural warrant for so doing. What type of soil will give us best returns in grass, either for meadow or pasture? Let us briefly consider the soil. An amazing thing it is to see how almost any soil is covered with plants, one nearly as densely as another, and when one comes to examine closely, one finds that on certain soil types one class of plants is found and on another soil type a quite different class of plants. For example, he will find walnut trees and bur oaks, ash and hickory for timber and when the land is cleared it will set to white clover and bluegrass. It will grow strong timothy and red clover, wheat, oats or corn. Under that soil there lies limestone, be well assured, and mixed through the soil is quite a good deal of carbonate of lime. Near by there may be seen another soil type; the trees will be beech and chestnut, pine and hemlock, sour gum and white oak. When this land is cleared it may set to redtop or Canada bluegrass, or perhaps

Border Leicesters at Pasture in Scotland.

no grass will naturally set there at all, and of the clovers alsike thrives best. If ferns and mosses come up in the field it grows steadily poorer and poorer because the clovers do not thrive, and so there is no nitrogen being stored from the wealth in the air. If one will take pains to examine that soil, one will find it made from material deficient in carbonate of lime and, most likely, deficient also in phosphorus, since lime and phosphorus often go hand in hand. The plain fact is that useful plants, the best in nature, love good soils just as good men choose to live in fertile lands. One can find a wealth of growth in an infertile soil but it will be growth of wild things that are not useful to man. To the intending land-buyer I urge, "Buy a farm in a region of rich soils; there you will find gathering the best men, the best animals will come from that soil and the best customs will develop there. Poor soils are never sold as cheaply in comparison with good soils as they deserve." However, one may say to me, "But I own my farm; it is not very fertile, I admit; what may I do to make it good? I also wish good meadows and pastures and fields of grain."

Importance of Drainage.—First, in the natural steps of development I should put drainage. Lead away surplus soil waters. A living soil has moisture through it, but also air in it all the time. Only inferior grasses, and no clovers, grow in saturated soils. Begin then by draining, and the best sort of drainage is underdrainage with tiles. Drainage alone will work wonders in a soil and the class and character of vegetation that covers it. Not only do better grasses grow on drained soils, but animals like them better. There is no doubt more sweet-

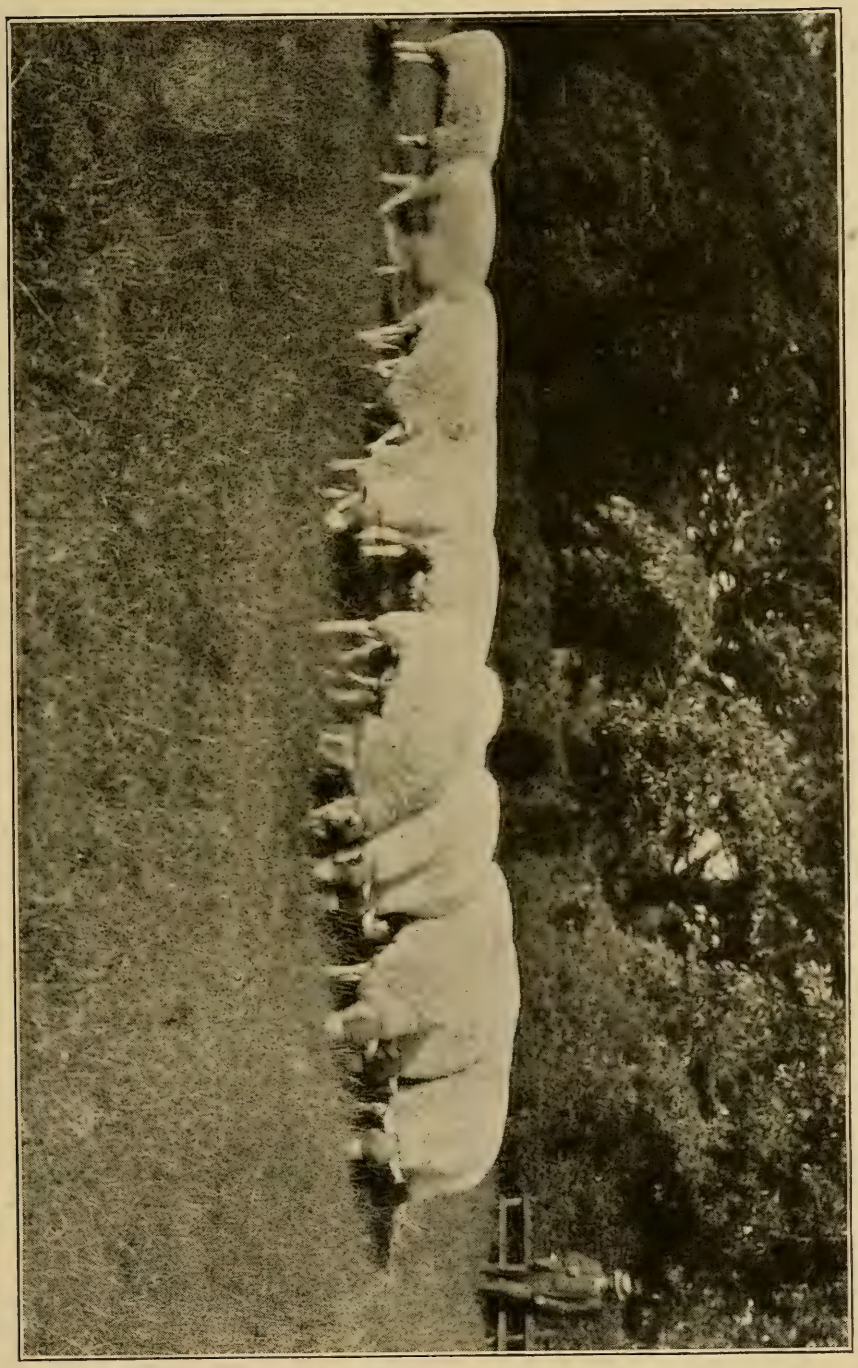
ness in grass grown on drained soil than in grass growing on wet land. I have seen wonders done in England and Scotland by drainage; there, at least, tiles were the foundation of soil improvement. I have seen heaths covered over with little worthless heather, barren of grasses or clovers, first deeply drained with tiles, then limed and enriched and afterwards made into as splendid meadows as I have ever seen. Remember always that clovers are the natural allies of grasses, and clovers thrive with their roots in soil in which there is air as well as moisture, since in no other soil can their roots bear the nodules which carry the bacteria that gather nitrogen from the air and thus enrich the soil for themselves and for their companion grasses. In any scheme of soil improvement then let drainage go first.

Depth to Underdrain.—Drains laid deep do most good. Here one must consider soil types and go as one must. Sometimes one can not lay tile work deeper than 30″; this depth will, indeed, give good results with grasses, but not so good with clovers. I have laid them at all depths from 2′ to 12′, and now we lay them, as nearly as possible, 4′ deep. In draining very rich soil that is to bear pasture grass alone, however, it may be that shallower drains will give better results; thus, in Holland, I have observed that men seek to keep the water level about 16″ below the surface of the soil. Indeed they often have their ditches so arranged that they can pump water into them so that it will seep back into the land and keep it moist in times of drouth. That land, however, seems unnaturally rich, and some unexplained plan of nature keeps it filled with nitrogen. No doubt

the feeding of cattle thereon, the careful husbanding of manures, the steady purchasing of foodstuffs to be fed in winter supplementing the grass, and the saving and use of liquid manures, may all help account for this maintenance of fertility with no great depth of soil free from water saturation. Then there are in that land certain clovers, both red and white, that do not need great depth of root; they grow well intermixed with the grasses, and all help to keep the soil literally as "rich as mud." In America under ordinary conditions I am sure that it is wise to drain as deeply as one well can; in Scotland and England I found glorious meadow land drained as perfectly as possible to depths of from 4′ to 7′.

Deep Drainage Prevents Effects of Drouth.—Curiously enough, deeply-drained land suffers less from drouth than the more shallow-drained, the reason being that, in the deeply-drained soil, roots learn to feed down to great depths. I have seen barley roots penetrate nearly 10′ in three months' growing, and all grasses root more deeply than we suppose. The fine fibrous feeding roots go far down if there is anything worth going after, but they never go into standing water; they drink the water that is called film moisture only. If we had conditions of soil and climate like the Hollanders, we could do no better than imitate their water meadows and pastures, but except along tidal flats and in a few isolated regions we can not so imitate, and must drain and prepare crops to feed and forage deep and wide during our seasons of heat and drouth.

Need of Carbonate of Lime.—Rich and productive soils everywhere are those which have enough carbonate



Grass Going into Mutton in Lincolnshire, England.

of lime in them. The function of carbonate of lime is well described by a writer signing himself "Robert Johnson" in "Hoard's Dairyman." His article follows:

"Out in Idaho is a very wide desert plain. For unnumbered thousands of years it has borne only stunted sage brush, tufts of scattered grass, coyotes and jack rabbits. Far below the plain, in a ragged rock hewn canyon, flowed Snake River. The desert plain was silent, untenanted save in winter time when snow made it possible for sheep and cattle to come out upon it and nibble the bunch grass. Men could not come there to live because no man alone nor neighborhood of men could dam mighty Snake River and take out its water, life giving though all men knew that water to be. The desert waited. Day came at last when one man crept down the precipices that walled in the river and in a tiny widening of the canyon he found a rift of soil and above it a spring. He stayed there to plant that soil and the alfalfa, peaches, apples, prunes thereof were splendid. Then this man came from his hidden oasis and told other men with gold and venturous blood of the land of silence, the wide plain, the prisoned river. Returning the men of gold came with him and together they traveled far over the silent land. Next came the engineers squinting long through shining instrument of brass, next armies of men with herds of horses; roads were made, villages of tents and board shacks sprung up, canals were dug across the plain, canals large enough to float any Atlantic steamship, lacking only in depth. Other armies of men pushed out perilously on the glassy rocks at the brink of waterfalls and with cement made piers and bridges and then with gates let down, the astonished river found itself trapped, dammed, made to flow away from its canyon into new canals. Content it crept their winding lengths, it penetrated quietly every lateral, every ditch; it spread itself out smiling over the land in tiny furrows. Thus was a river lost and came to be only moisture of an irrigated plain so wide that no man could see across it.

"Thus was regained Paradise, land of orchards and meadows. Then came men from many lands, men with plows and harrows, with hoes and shovels, men driving rumbling wagons, building tiny houses of boards, bringing women and many children, planting trees of poplar, apple and peach. Thus was tamed and made into farms and orchards and gardens the mighty desert, wild and drouth

stricken desert, of Idaho on either side of winding Snake River. Thereon sit many villages, towns and even cities, while long lines of towering poplars reach up to proclaim the tale of a land made glad. And yet, curiously enough, the land smiled doubtfully at first when water was turned on. Wheat made only about 20 bushels to the acre, potatoes no more than 100 bushels. These rewards, ample enough in Ohio or Pennsylvania, were quite inadequate in the far off desert. Men freely predicted that it was a mistake settling the desert plain, that the millions of dollars thrown into the river and its canals would be forever sunken and lost, that the land was too poor to make farming profitable. Chemists examined the soil and learned that it was rich in phosphorus, rich in potash, made indeed from volcanic ash and decayed lava rocks, but that it had in it little nitrogen. Now nitrogen is the life of soils, the quickening wine that invigorates plants.

"Nitrogen is the essential element in protein. Soils nearly everywhere are starving for nitrogen, so are the world's poor, both man and beast. Nitrogen comes from the deserts of Chili, from blood of beast, a little from nitrogen factories in Norway where the electric furnaces take apart the air and make captive that elusive element. So these farmers on Idaho's plains could have brought nitrate of soda from South America or bought dried blood from Chicago, only that the crops harvested would not have repaid that price and the great length of travel. Clearly the land was doomed and the settlers thereof to poverty and unprofitable toil, unless some home source of nitrogen could be found. Not that the farmers themselves knew clearly what was wrong, to them it was only that 'The derned land is poor.' Whether it had lack of phosphorus, potash, nitrogen or what not, they knew not.

"There was another curious thing about that soil that we have not considered; it had in it four percent of carbonate of lime. That is a most extraordinary amount of lime for an American soil, its origin from volcanic ash, from decayed lava rock gave it the lime. Soils of Maryland or New York have in them usually not one-tenth that much lime, maybe not one-fiftieth as much. When wheat did not seem profitable or potatoes, some sowed alfalfa. The alfalfa grew gloriously after a time. At first it sometimes failed to grow well, but presently some miracle happened and it grew like Jonah's gourd. That was when bacteria got to work. Men cut it three or four times during the summer and harvested as much as

6 to 10 tons of hay to the acre. Afterward some plowed their alfalfa fields and planted them to wheat, to potatoes. Herein was seen a miracle, the wheat yielded as much as 75 bushels to the acre and the potatoes 600 bushels. There was now nothing wrong in the soil, it was complete in its fertility and producing power. Whence came this increase? What had happened to that soil?

"What had happened was simply one of God's miracles, one of the things that God had planned when He made the world, no doubt. Nitrogen He knew must be in soils, must be in foods, the air was full of it but not in such form that plants could absorb it, so the legumes, the clovers, were planned to store soils with nitrogen. Alfalfa is a clover, a vigorous, long-living clover. Alfalfa leaves are as unable to absorb nitrogen as are the leaves of other plants, so were designed little living organisms called bacteria, especially fitted to digest the nitrogen that is in the air—digest it and assimilate it and dying to turn it over to the plants. So the marvelous productivity of the Idaho desert soils is based on their large content of carbonate of lime, that and the fact that they are permeable by water and air and have enough phosphorus, potash and other plant foods.

"Those farms of Idaho are sure of a splendid destiny. They are rich in mineral elements of fertility and because of that the alfalfa can for thousands of years be counted on to bring to them their nitrogen. One knows well that there will ever be a land of fertile fields and great crops in that wide, western valley, that never fear of hunger will be felt between those ranges of snow-capped mountains as long as the river flows peacefully through canals and loses itself in cool depths of alfalfa or wheat or between rows of apple trees, pink and white with bloom or gleaming red with apples in October. Seventy-five bushels of wheat to the acre grow in Idaho, 600 of potatoes, while in the eastern states wheat yields from 8 to 20 bushels and potatoes in good years up to 150 bushels. Near 2,000 miles of railway haul to bring food from Idaho to New York, and within driving distance of New York, Philadelphia, Baltimore and Washington one finds abandoned fields growing up to pines and bushes! Why do we not develop fields near at home? To irrigate that land in Idaho costs from $50 to $100 per acre, here are fields on which God makes rain fall in gentle showers all through the crop season. What is wrong in the East?

"First, let me say it is not the men that are wrong. They are as good men who inhabit the infertile farms of the East as the men

who live on Idaho's plains. The chief difference is that the strong, prudent, daring ones have gone to people the West. Those who remained at home remained to combat a stubborn soil fact.

"Wherever men have found a soil strong in carbonate of lime they have found a soil rich and a soil easily kept rich. All the great and enduring civilizations in the world have been built up on soils that had an alkaline reaction because of their abundance of carbonate of lime. Civilizations that did not endure were founded on soils that were sour. Men came from food, after all. Food comes from fertile soils. Soils are fertile in proportion to their being alive, to their having life-giving bacteria in them. These bacteria most abound where there is much carbonate of lime. In France large use is made of lime and the result is a fertility and bloom and harvest unknown in America. In France, in summer one sees wide stretches of blooming fields of clover, alfalfa and sainfoin. Lime makes these things grow. They in turn enrich the soil and make it ready for wheat. Thus are the people of France fed from the stones. Thus are fields in France, that thousands of years ago were cultivated fields, today richer than any we find in eastern America, where the land has not been plowed yet for two centuries.

"Have we no fields, then, that have been limed in the East to show what results might follow? Prof E. B. Voorhees on well-limed land in New Jersey grew last year more than 7 tons of alfalfa on one acre. The land is exactly similar to what other Jerseymen call poor, and prove to be unproductive. On that alfalfa field he could now grow 100 bushels of corn or 50 bushels of wheat. Would it not do something to relieve the hunger in eastern cities, were there a million such fields along the Atlantic Seaboard? Would that not reduce much the cost of living? In Pennsylvania, within driving distance of Philadelphia, lives Wayne MacVeagh. Older men will remember that he was once Attorney-General when Garfield was President. MacVeagh farms well. Loving his soil, he feeds it liberally; the cattle of this man are good. Wishing then to provide yet better forage for his animals, MacVeagh sowed alfalfa but the alfalfa throve not. Learning that alfalfa needs carbonate of lime he spread that over his field and harrowed it to mix it with the soil. He did as God did when He made the soils, taking ground raw limestone rocks and mixing the dust through the soil. Full six tons to each acre he did spread. Then also he put on phosphorus, and with that he waited. Soon a miracle appeared in that

field; the alfalfa that had been yellow, sickly and in despair became all at once alive, bright green, full of thrift and vigor. It produced several very heavy crops of hay; it beautified the hillside; it enriched the soil; it made the old man see a vision and caused him to plan wisely and well to cover yet more fields with lime, mother of alfalfa; to cover more fields with alfalfa, to better feed his cows and better feed his land. Carbonate of lime is the key, then, that unlocks the strong door leading to soil enrichment in the East.

"Would you hear another story? There lived in California a man named J. F. Jack. This man knew of ranching and irrigation, of alfalfa, oranges and farming. He had never lived in the East. Because he wondered that God out of His goodness made it to rain on the eastern farms while He left the western farms dry, Mr. Jack went to Virginia to study the strange situation. At that time he did not know that the long drouth of the West, enduring for unnumbered centuries, had saved for them their carbonate of lime; he did not know that eastern soils are starved for it. Because he liked the people of Virginia, Mr. Jack bought a great plantation on the Rappahannock River. There he essayed to make alfalfa grow and at first it would not grow. Then he took counsel with wise men in the Department of Agriculture and they told him of the lime need of his soil and how it was famished for humus and hungry for phosphorus. He brought lime, crimson clover followed, that turned under made humus and alfalfa was sown. Last year from 300 acres of once worn-out land, Mr. Jack harvested 1200 tons of alfalfa hay. Afterward he had a shipload of ground limestone brought to his wharf and in one summer 700 tons more of the life-giving carbonate of lime went out to his soil to make ready more acres for alfalfa. Some day there one will see a thousand acres in one glorious alfalfa field, a most hopeful thing for old Virginia, a thing that should make Virginia farmers, young and old, think long and well and take new heart.

"Here is fresh field for exploitation. In Jersey are thousands of acres of land turned out to pines. The land is termed poor, and they say well who call it poor. It has in it no life-giving carbonate of lime and little of any other element of fertility. No man can now till that land and make it pay. Yet from those barren fields one can drive with two horses and a farm wagon to the crowded streets of Philadelphia or New York. Prof. Voorhees has shown that this land can easily be redeemed. Here lies the way. First

carbonate of lime enough to take away the sourness of the land and make it sweet instead. Next some good growth on the land to turn under and make life in the soil. Crimson clover or cowpeas will do that. Then alfalfa or red clover, and after these crops the stubble when plowed will grow gardens or potatoes or corn. True, one must buy phosphorus; that costs not much when the lime is in the soil, for a pound of phosphorus will last as long on land with lime in it as 5 pounds will when the land is lime-hungry. In Jersey are great mountains of limestone rock. Crushers there are and grinders ready made to powder this rock and railways ready to take it to the soil. It is almost parallel to the story of Idaho; there flowed the Snake River in its deep canyon, doing no manner of good to herb or tree. There came strong men and turned Snake River out to water the fields. Here lie solemn mountains rich at heart with priceless carbonate of lime; near by are barren fields suffering for this one thing. Now should men come to grind this lime and make channels to carry it out to the fields? If men with gold wished they could indeed buy these Jersey lands for any song and fill them with lime, sow them to alfalfa, make them rich and beautiful and sell them again to farmers who would use them to make food for the markets of our cities. It is a work that should belong to strong men, for the need of such lime is great, ten full tons of ground and unburned lime dust would be none too much for an acre of hungry land, and men with means could own their own railway cars and grinders and put the stuff out for a small price and in large amounts.

"Strange it is, but in Illinois, state of rich soils, most has been done in this endeavor. There Dr. Cyril G. Hopkins has persuaded his state to set convicts to grinding limestone in the penitentiary at Menard. There the men grind the stone and load it on cars, and the state sells it to the farmers for 65 cents a ton, and the railways, wishing to make farms more productive so that they in turn might have the freight to haul, do haul these cars of stone dust a mile for 20 cents, each car laden with 40 tons of ground limestone.

"It is a wonderful thought, is it not, that men leave their land near eastern cities, crowded with hungry people willing and able to pay their price—leave these old states and migrate to the arid West, thousands of miles from their customers and there expend more money to get water on the land so that they may grow crops to feed the people of the eastern cities than they would have had to expend on their old acres near those cities in putting carbonate of lime on

their fields, putting alfalfa or clover there, getting fertility there so that they could have grown bounteous crops right at their hungry customers' doors! It will take less money to make acres fertile in Jersey, Virginia and New York than it will to water other acres already fertile but arid in the far off West."

In Maryland one sees shell roads built through soils so sandy that they are half barren. Where the wheels grind up the shells into dust and the dust is washed down over the soil, bluegrass and white clover spring up and a good sod is made. Bear in mind that there is a good deal of horse manure left there besides the carbonate of lime. The ground shells alone might not have done and probably would not have done the work. In Alabama on sandy coast land there is growing fine alfalfa, the work of carbonate of lime applied liberally. In Florida the same story is told, and in truth wherever man has used carbonate of lime with intelligence he has had meadow or pasture to show for it.

Further, carbonate of lime changes the character, even the species and varieties, of grasses and clovers growing on a soil. When it is deficient one sees broom sedge (not a good grass), redtop, Canada bluegrass and many other grasses of inferior value. With the balance of carbonate of lime restored, the soil is made sweet, clovers enrich it and the broom sedge disappears, as do the redtop and Canada bluegrass and are replaced with Kentucky bluegrass, timothy and clovers.

There is yet another side to the carbonate of lime matter. Where it is abundant in soils grasses growing there are sweet and well-flavored, and animals relish them. Thus one may find parts of a pasture eaten down close and other parts neglected, the parts eaten close being

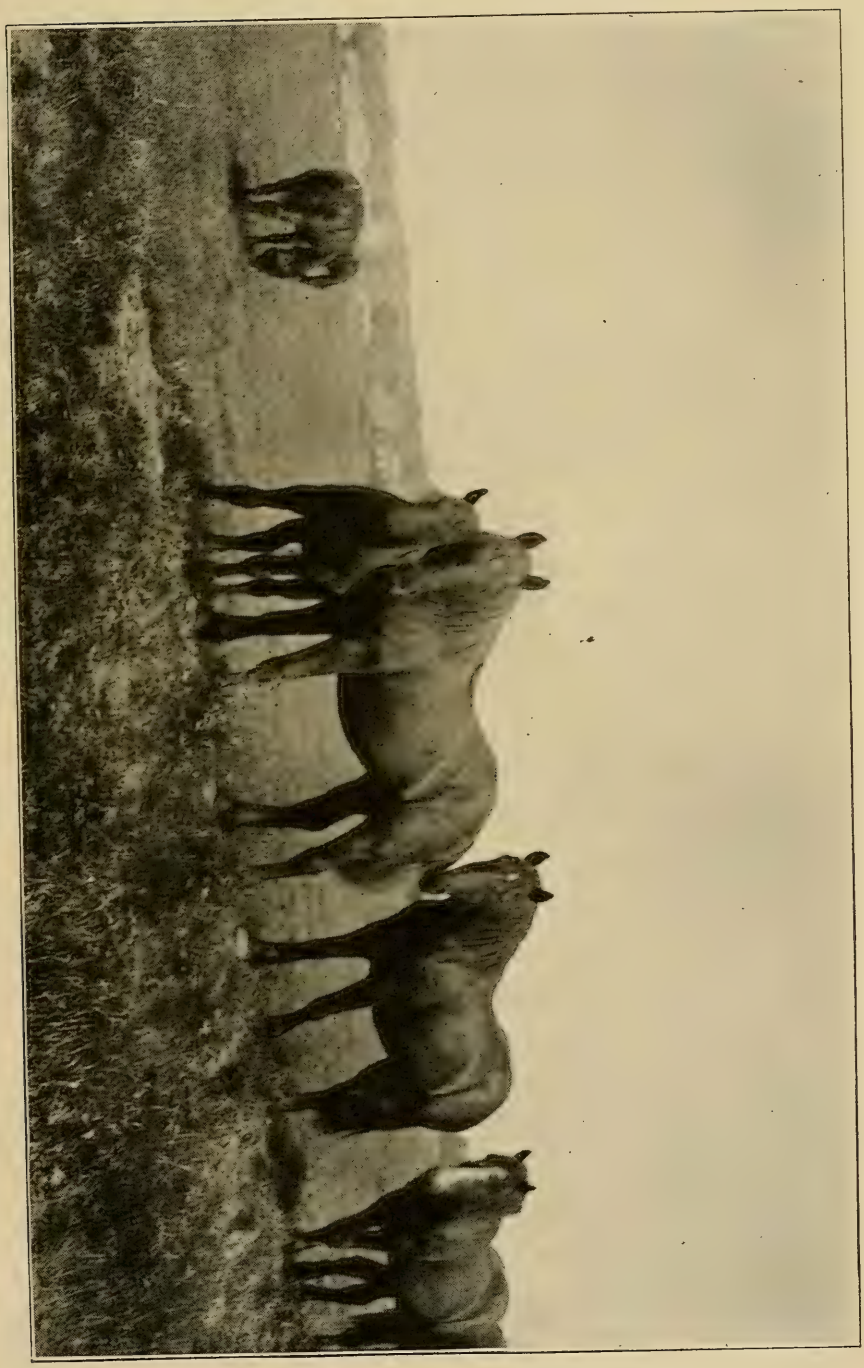
where there is most lime in the surface soil. I have often observed on our own pastures that on certain hill-tops and slopes where erosion has put the limestone pebbles in the surface soil the horses gnaw the grass to the earth, while in other parts of the field with less lime in the surface soil the grass is left uneaten.

Lime Sweetens Pastures.—Experiment has shown that animals so much prefer the grass that grows on limed soil (supposing it to have been lime-deficient) that there is nothing that pays better than to sweeten old pastures with lime before any other work of improvement is begun, though this and drainage go right together. One can not have sweet grass unless it is on land free from both soil acids and excess of moisture. If an old pasture is to be sweetened the lime may be applied as a top-dressing, in any form most convenient, either ground limestone, freshly-slaked quick lime applied in powder form, air-slaked lime, or carbonate of lime. Naturally the least harmful form is the raw ground limestone, and when this is available at a low price it should be chosen. The amounts that are advisable to use are, of fresh-burned and slaked lime, from 2 to 4 tons to the acre; air-slaked lime from 2 to 6 tons to the acre; carbonate of lime from 2 to 10 tons to the acre.

I recall an amusing instance of the effect of raw powdered lime dust on pasture. A friend in the bluegrass land of Kentucky allowed a contractor to take from his field stone which was crushed and carried to the highway. The crusher made a good deal of dust which the wind carried to the leeward until several acres were more or less powdered with the white dust. My friend was

much disturbed to see this dust and to observe that the cattle refused to eat the grass where it lay, and suggested to the contractor that he owed damages for this nuisance and to this the contractor agreed. Then a rain came and washed off the grass and put some of the dust into the soil. Afterward there was very marked difference in the aspect of the grass, the dusted grass being markedly superior and much more greedily eaten by the cattle, so that my friend laughingly recalled his complaint. It seems fairly effective simply to dust lime over the sod on old pastures, though doubtless much of it is slow to be worked down to where it is effective and sometimes it would be advisable to disk or harrow it into the soil. If there is a good sod, however, the earth worms will be abundant there and their casts will be laid above the lime particles so that finally they will be worked down to moist earth.

Effect of Lime on Pastured Animals.—In some regions it is common to find animals licking the lime wash from fences and buildings, gnawing bones, and in other ways displaying their lime-hunger. No good animals can ever be produced on such soils—at least not until they are corrected. Lime-hunger in a soil means lime-hunger in plants and lime deficiency there, and that, in turn, means animals eating the herbage will be deficient in bone, in stamina and substance. Furthermore, animals in heavy milk can not possibly maintain their natural body lime content, as has been shown by experiments at the Wisconsin station, and this lime exhaustion in the milk-giving animal is doubtless responsible for much of the breakdown among heavy milkers.



In a La Perche Pasture in France.

Animals and Pastures Rich in Lime.—There are pastures noted the world over for their splendid animals. At Nogent-le-Rotrou in France I was shown pastures on which could be produced the most splendid types of Percheron colts. These pastures were where they had the river wash from the Huisne, a stream that breaks through hills of soft limestone. These bottoms are doubtless very rich in lime and in phosphates too; they bear splendid thick grass, and colts grazing on them will make marvelous development, while if they were pastured on the sandstone soils a mile away they would make only common work horses with no hope of coming to America as founders of a new race. In England it has long been recognized that pastures rich in lime and phosphorus made the best race horses and the best bone in drafters. So much is this believed that breeders there do not hesitate to go to great lengths artificially to lime pastures devoted to mares and colts of royal blood. There carbonate of lime in the shape of chalk is commonly used, though more or less burned lime is also applied and very much lime in combination with phosphorus in the form of basic slag. In our own land we have the example of Kentucky sending out a steady stream of splendid colts, bulls, sheep and men from that central region where the rich limestone lay near the surface, and where their decay has left the land rich in both limestone and phosphorus. There are other regions nearly as notable, and many a failure has been recorded where men have taken good animals to soils deficient in lime and sought to breed young things as good as their sires and dams. Without exception, if they depended on the herbage of

the natural pasture, the attempt has resulted in failure. One of the regions where the effect of lime in the soil is most markedly shown is in our own arid West. In that region there is commonly about 2 to 4 per cent of carbonate of lime present in the surface soil, and grasses growing out of that land are very sweet and nutritious. Furthermore, the water of spring and stream is invariably impregnated with lime salts. Horses grown on the grass of that land have astonishing bone, hard, dense and nearly four times as strong and tough as the bone of horses grown on grasses in lime-deficient soils of the East. In France the Government once made examination of soldiers, grouping them according to their birthplace, and found that those from regions where limestone abounded were nearly 1½″ taller and correspondingly stronger and healthier than those from the lime-deficient lands.

Feeding Lime and Bone to Animals.—While there is lack of accurate data as to the effect of feeding mineral substances directly to animals where the herbage is supposedly lime-deficient, yet we have proof that there is considerable gain in the practice. If one has not yet sufficiently limed one's soil so that the forage has in it normal or above normal lime supply, one can lime the food or water that the animals drink. There are several ways that this has been done. L. Ogilvy of Colorado has placed lump lime in the drinking troughs with good results, and says it is a practice among some successful horse breeders in England. The amount of lime should be small; a piece of fresh-burned lime as large as an egg dropped into a troughful of water say once or twice

a week would seem to afford lime enough. Air-slaked lime may also be mixed with the salt at the rate of about equal parts, and the mixture kept always before animals, so that they will not become hungry enough for salt to eat too much at one time. Bonemeal is prepared especially for stock-feeding and may be fed in any amount; what is not digested and retained will feed the pasture.

Example of What Lime-Deficiency Will Do.—I know land that appears at first glance a paradise for animals and men. It lies at an altitude of between 3,000 and 4,500 feet in the southern mountains. It has rich, black soil filled with humus and a thousand springs of sparkling soft water. The grasses and clovers grow fairly well, though the shyness about either to remain in the land is indicative of lime-hunger. The water is like distilled water. The cattle of that land are very small, with especially small bone. The men are short, slender and not strong. A friend cleared up a large sheep farm there and put on it Southdown and Shropshire sheep of fine breeding. He gave them intelligent care, yet steadily the flock deteriorated, the size ran down, the bone diminished, health and vigor were hard to maintain, and at last the down sheep were replaced by Merinos which throve far better for the very evident reason that Merino lambs are far slower in maturing than the downs and thus had time gradually to accumulate what lime they needed for bone-building and body use. While these pastures were too inaccessible to have lime hauled onto them, I think the flock could have been maintained by the simple expedient of feeding bonemeal and putting lime into the drinking water and the salt.

Bonemeal and Basic Slag.—As sources of lime and phosphorus, bonemeal and basic slag must be considered. Bonemeal is rich in phosphorus, has some nitrogen and considerable lime in the form of phosphate of lime. There is hardly any fertilizer so good for stimulating grasses and clovers as bonemeal. Its one drawback is the price, but this is commonly paid back and often several times over. There is no fear of bonemeal leaching from the land; it is a permanency once applied. I have seen marvelous results from its use in the South where it is in common use for lawn-making on very infertile soils. The fact that bonemeal supplies some nitrogen as well as phosphorus is all in its favor in establishing and feeding grasses and clovers.

Basic slag is a by-product of the steel-making plants. Foreign ores have a surplus of phosphorus, which is removed by smelting them with limestone, the lime united with the phosphorus making phosphate of lime. The slag is ground finely, and the finer it is ground the more valuable it is, since it is more available. It may contain 15 to 20 per cent of phosphoric acid and 50 per cent more or less of carbonate of lime. Basic slag is the foundation of pasture improvement in the Old World. Its use brings in better grass and many clovers. It seems little less than miraculous to see how the sods become covered over with young clovers where basic slag is used on pastures in England. Unfortunately, our own steel mills do not make basic slag and the freights from the Atlantic to the Middle West are almost prohibitive of its use.

Lime, Drainage, Phosphorus, then What?—After all, one can not make a short cut by chemical means to na-

ture's results in fertility-building. Nature builds soils by long accretions of fertility and by slowly accumulating organic matter, humus. We can not put mere chemicals into a poor soil and get the same results that nature gives in her slower way. Vegetable matter is needed. The slow decay of organic matter in the soil is needed to promote nature's wondrous soil chemistry. The soil is a true laboratory. There are little bacteria living on decaying vegetable matter that do miracles there, gathering nitrogen of their own accord, and other bacteria in that very mysterious place, the soil, are at work too. Make the soil sweet, feed it phosphorus, and potassium if need be, but after all this is done add all the organic matter you can. Manure makes land rich now as it did in the days of our fathers. Chemicals help, are essential, indeed; but after them one must conserve organic matter and increase it all one can.

Two Lessons in Meadow-Building.—Some years ago we bought a very poor field and began work at reclaiming it. One corner was especially unfertile, a cold, wet clay. We drained this corner, then enriched it well, spreading over it a good deal of stable manure. The rest of the field was, some of it, very fertile land and had naturally less manure, though all the field had more or less manure and all alike was treated with phosphorus. The land was sown to alfalfa. At the outset the alfalfa on this poor corner was lighter than elsewhere, but after two years the heaviest growth came from this part; the field was reversed and what was originally the poor corner became the most productive. There would seem now no reason why this condition may not be maintained.

The other lesson is of a field not manured but deeply plowed and cultivated 20 times, then fertilized with various artificial fertilizers, no manure given, and seeded to grass under the "Clark method." A good stand of grass was secured and the first year saw a heavy crop of hay. The following year, however, the yield was but ordinary and the third year saw the field in worse condition than those about it. The evident lesson is that the deep plowing, the frequent cultivation during warm weather preparatory to seeding the crop, used up a good deal of the humus needed to make the land have moisture-holding and bacteria-growing qualities, so that the last state of that land was worse than the first. It may be that had this field been top-dressed with manure after the first year it would have maintained itself, but it is clear that chemicals alone on soils deficient in humus will not make permanently for large yields of grains or clovers.

Manure in Soils like Yeast in Bread.—Manure, vegetable matter decaying in the soil, acts much as does yeast in the moist dough; it starts ferments, bacterial processes, some of them understood, some of them not. For example, we once bought a poor field and at once re-sold half of it to a neighbor. Our half we treated with acid phosphate, tankage, good plowing and a very slight sprinkling of manure. The land was then sown to clover with oats or barley. Our neighbor imitated us exactly except that, having no manure, he omitted it. We secured a good stand and a fine heavy growth of clover. Our neighbor secured a fair stand and a light growth. The amount of manure applied was insignifi-

cant, so far as the actual fertility contained in it, but it was pregnant with results when it came to act.

Cowpeas and Bluegrass.—In Virginia the best farmers desiring to sow worn limestone clays to bluegrass commonly put the land first in cowpeas, which are turned under with all their growth. Afterward bluegrass takes well and the effect of the peas is seen for some time; whereas it might be nearly impossible to establish the

Bluegrass (40 lbs. green) from a square rod of Unmanured Land—Equal to 6,400 lbs. green per acre.

bluegrass. The conclusion is irresistible: manure, vegetable matter decaying in the soil, is the mother of grass and clover.

Moisture the Limiting Factor in Grass Production.—What limits the production of meadow or pasture is the moisture supply. In not one year in a century is it ample at all seasons. Plants drink their food, and can make no growth in dry soil. It is best, therefore, to devote the better more moisture-holding soils to grasses, and put

the drouthy soils to cultivated crops. Moisture is conserved by deep plowing and cultivation of the soil. Deep plowing on certain types of soil will help the grass, but cultivation after once meadow or pasture is laid down must cease. Alfalfa meadows are sometimes tilled after being cut, but no other meadow plant seems adapted to this culture, and it is hardly proved that it is profitable so to treat alfalfa. It is notable that soils well filled with

Bluegrass (125 lbs. green) from a square rod of Manured Land—Equal to 20,000 lbs. green per acre.

humus hold more moisture than those without vegetable matter, as the latter dry out like brick and are not well adapted to the growth of shallow-rooted grasses. If one wishes to grow grasses on these hard soils one should strive to get into them as much manure or vegetable matter of any kind as can be secured, and afterward try so to manage that the grass will in a manner mulch itself by leaving enough of it to shade the land. There is great virtue in shading land, thus preventing injury

from sun-burning. Some careful pastoralists manage their pastures so that the sun never reaches the earth because the grass is never eaten down bare. Animals are kept off in spring till the grass has a good start, and afterward the amount of stock turned to pasture is so proportioned that the grass is always a little ahead of the beasts grazing it.

Making Water Meadows.—In England and the continent of Europe the effect of irrigation of meadowland is well understood, and there when it is possible grasslands are arranged to be irrigated. I have seen in England water meadows so old that each little ditch bringing irrigation water was situated on the summit of a little ridge, whence the water flowed gently in every direction. The ridge effect was the result of countless grains of sand and silt, brought by water through the long years that it has run in these meadows, depositing in the entangling grass blades and among the roots, thus steadily building the soil each year a little higher. It seems the practice in these meadows to allow the water to flow in almost continuous stream, though it is so distributed that only a trickle goes out at each point where it is diverted. The yield of grass obtained from these meadows is large, so that they commonly bring rentals of £3 and more per acre, whereas, common meadow land may bring no more than £1. I have seen no water meadows in America comparable to these of Europe since here irrigation is almost altogether confined to the arid West, and is given chiefly to alfalfa, though along the eastern slopes of the Sierras in California and Nevada I have seen irrigated pastures of bluegrass and

white clover that yielded marvelous burdens of forage. Furthermore, cattle on those irrigated pastures become as fat as we can make them in Ohio with grass and corn. I think one of the first works that should be undertaken to increase the production of grass, beef, mutton and colts on eastern fields should be to begin to utilize our streams, now all running to waste, in irrigating grass fields. It is not, of course, possible except in exceptional locations, and the first installation costs labor and money, but after once it is installed the maintenance is very cheap and the production of the land should be nearly trebled. Water meadows, however, commonly need no other fertilization than that brought by the water, and build themselves steadily in fertility from year to year.

Where Grass is Most Profitable.—The fact that the moisture supply is the limiting factor in the production of meadows and pastures determines to a considerable degree their profitable placing. Where there is abundant summer rainfall there grow the rankest grasses; where heats and drouth prevail there one must plow and till in order to reap. Thus New England, New York and the moist mountain valleys of Virginia seem the most natural grass regions of the United States, though good production is seen as far west as the Mississippi River, and south to the line of Tennessee. Iowa, Missouri, Kansas and Nebraska have decreasing rainfall and hot summers; here evidently, deep-rooted crops such as alfalfa, or tilled crops such as corn or sorghum, are most profitable. Thus in Oklahoma and the Panhandle of Texas it once required 20 acres to keep a steer a year on the short but thick and nutritious grass that was

native to the region. No growth could take place during most of the summer months, and only during periods of rainfall could grasses advance. In those regions the advent of the plow was truly in accordance with sound practice, for by deep plowing and good tillage much moisture that falls in winter is conserved and the deep rooting corn, sorghum and Kaffir-corn make good growth. I have seen sorghum stalks 12′ high alongside the native buffalo or grama grass 4″ high. The lesson is clear: In hot countries there is always lack of moisture near the surface and there one should plant things that root deep or plant annuals that permit good soil culture in preparation of their establishment.

Seeding the New Grassland.—We have now taken a general survey of the situation. Let us get out and sow down a bit of pasture or meadow land. First, scan the land itself. Let us walk over it. Is it well-drained? If not, choose where tiles or open ditches will best draw away the water that, stagnant in the land, brings in rank stuffs that we do not want and discourage the good things. Is it sour? We can after a little experience and observation judge of that, and if we are in doubt we can test the soil with a few drops of hydrochloric acid and see if we get effervescence, or we can adapt our grasses to a sour soil if we do not care to sweeten it with lime. Then we study its fitness in the matter of accumulation of vegetable matter, humus. If it is very sandy, gravelly or clayey, and has in it little organic matter, we must do something for that sooner or later. Perhaps we will wish to plow first, then run the manure spreader over the field and disk in the manure left there. And

finally to the questions of how to plow, when to plow, when to sow, and what to sow.

Plowing.—There assuredly are soils that are helped enormously by deep plowing. There are other soils that need to be kept religiously "right side up." There are thin soils with an inch or two of top stuff brown with slowly accumulated humus and beneath very dense, cold, poor clay. Suddenly to turn such land over to a depth of 12″ or more would be to court defeat unless one had a considerable quantity of manure that one could apply. In event one has the manure and will mix it in well, probably the deep plowing of this hard poor clay would be useful, and might result in much better grass than would come with shallow plowing or mere disking; but to turn suddenly that dense subsoil to the surface and attempt to make in it a seedbed for a tiny grass plant, would be to court disaster. There are soils, however, so deep, with subsoil immediately under them well filled with carbonate of lime, that the deeper they are plowed within reason the better the results will be. On such soils we are plowing 14″ deep, and more when laying down to alfalfa, and we would not hesitate to do the same in laying the land down to grasses. As a rule, however, with many exceptions, when making a seedbed for grasses, keep the soil as near right side up as you can and try to have in the upper surface as much decaying vegetable matter as you can get. Imitate the natural sod which is a mass of decaying stems, leaves and roots.

However deep the land may be plowed, here is a rule that should be inviolable: plow early. If the seeding is to be done in the fall, plow if possible in midsummer.

The land must settle together again, so that the capillaries will be established and moisture can come up from beneath. The land must not only be plowed early, but it must be frequently harrowed afterward, and the first harrowing should be within three hours of the plowing. To accomplish this one may plow till 10 o'clock in the forenoon, harrow the fresh-plowed land till noon and repeat the operation at 4 o'clock on what is plowed after dinner. By this means good pulverization is secured and moisture conserved. To further moisture conservation one should harrow with a steel drag harrow (or any other sort may serve) soon after each rainfall, as the land will work nicely without packing. The land should be carefully dragged till it is level and smooth.

Top-dress With Manure Before Seeding.—If the field can have a top-dressing of fine manure, harrowed in and mixed all through the surface soil, it will assure a fine catch and rapid growth. Manure turned under will not soon benefit the young plants.

Application of Lime.—When liming is needed the work may be done either before or after plowing. Carbonate of lime may be stirred into the soil with the harrow and if it comes in contact with the manure no especial loss will occur. Caustic lime should not touch manure, and it should be well mixed through the soil before the manure is applied.

Time to Seed Grasses.—Nature ripens grass seeds in the summer; they fall to earth and lie dormant till rains of fall cause them to spring into growth. Commonly the fall is the best time to sow grass seeds. If one begins one's work of preparing a seed bed in late summer,

one can make a seed bed fine and fit by September. One should not sow the seed until the ground is sufficiently full of moisture so that if the seeds germinate they will not perish for lack of support. Time of seeding varies with location and with season. In the fall one can sow grass seeds from August till November, with the best chances of success probably about the middle of September. In the spring one can hardly sow the seed too early; certainly as soon as one can get a seed bed one must put in the seed, and in spring seeding one can not and need not delay so long to perfect a seed bed as in the fall.

The Mixture to Select.—Many grass mixtures compounded by seedsmen are silly agglomerations, with the bulk made up of good varieties and many poorer ones added literally to throw chaff into the eye of the customer. There is not a long list of good grasses adapted to any soil. For example, if one has a soil adapted to Kentucky bluegrass, and wishes to grow that grass, one has no use for Canada bluegrass, redtop or a lot of other grasses listed in seedsmen's catalogues. Mix with bluegrass meadow fescue, brome grass and timothy, the latter to come on soon and afford temporary pasture, and the others because all three are good grasses liked by animals. One is unwise to sow orchard grass where one desires bluegrass, because it is stronger and coarser, and is not eaten by animals that can get bluegrass. For a poor soil deficient in lime, use redtop, Canada bluegrass and orchard grass. For mowing, in soil deficient in lime and fertility, sow orchard grass, tall oatgrass and redtop. For good soil with sufficient moisture, sow a mowing

grass, as timothy. A second choice for good soil and plenty of moisture is timothy. For wet soil and lime-deficient but yet fairly good, sow timothy and redtop. For pasture or meadow in the Northwest, sow brome grass and meadow fescue. For pasture and meadow in Kansas and Nebraska, sow timothy, brome grass and meadow fescue. For winter pasture or temporary lawn in the South, sow Italian rye grass, and so on through the list. The reader, after studying the chapters describing the various grasses, will have little difficulty in making out his own mixture or choosing a single grass to sow alone.

Mixtures vs. One Grass.—Hunt says that no mixture will afford more forage than will a single grass sown alone, if it is adapted to the soil and climate. While there is doubtless exaggerated expectation of the efficiency of mixtures, I must say I have seen evidence that mixtures for pastures are good in their way. The evil of a mixture is that sometime there is in it a grass of inferior quality; that one will be neglected and the others grazed, so that after a time the inferior grass is left in the ascendency. Thus it is folly to mix brome grass with orchard grass or bluegrass with orchard grass, since animals commonly leave orchard grass untouched when they can gnaw the more delicate grasses, and yet orchard grass is nutritious and palatable and eaten well when growing alone. When one is not sure of one's soil one may find that in the "shotgun mixtures" of many seeds one will find some that will be especially well adapted, and thus achieve better results than if one seeded at a venture one grass alone. For hay one must bear in mind

that nothing sells so well as timothy and any admixture decreases the price obtainable.

Amount of Seed to the Acre.—Grass seeds are commonly very minute. Thus of bluegrass there are 2,400,000 seeds to the pound, of redtop 6,000,000 and of timothy 1,700,000. If, then, one pound of bluegrass seed could be evenly distributed over an acre, it would place about 55 seeds to the square foot, a number ample to give a good stand of grass. However, it is nearly impossible to get a perfect distribution of seeds, and quite impossible to get them covered evenly, so that one can not count on more than a very small percentage of germination. There is the further fact that when the little seedling grass plant comes to light it is very weak and small, and alone is pretty sure to perish. Literally, in union there is strength. I have sown grass seeds in the fall and later seen perfect stands where the seed was sown "too thick," and very poor stands indeed where it was sown "just right," as we had believed at seeding time, all the other care alike. With the smaller seeds then of the bluegrasses, redtop, and others of that nature, the thicker the seeding the better the hopes. I should not hesitate with these seeds to put on 20 to 30 pounds to the acre, no matter if it does seem too liberal a seeding. Of timothy, orchard grass, brome grass, and seeds of like size, one can sow much less seed and get good stands. I found by experiment that timothy sown very thick gave a very reduced yield, and Hunt found that because of timothy's strong stooling habit a single plant had given 125 pounds of well cured hay. Only 3,200 plants such as that would be required on one acre to

give a yield of 2 tons of hay, or one plant to about each 14 square feet. When 9 pounds of timothy are sown on one acre over 200 seeds are left on each square foot. When sown alone 10 to 15 pounds to the acre are commonly sown, and if clover is to be sown with it 8 to 10 pounds, and in the spring as much red clover or clover mixtures. Commonly it is wise to err on the side of too much seed, timothy on rich soil seeming the exception that goes to prove the rule.

Aiding Young Grass Seedlings.—Anything that will keep the earth moist and shaded while young grasses are getting started will be a real help. To distribute chaff or light manure over the field would aid. Chaff from the mangers or feeding floor will often result in a stand of grass, when sowing pure seed would fail simply because the chaff would keep the earth from too rapid drying out. Further, to make the surface quite firm and almost hard after the seed was sown would be a distinct gain since it would tend to hold the moisture near the surface.

Sowing the Seed.—In my father's time men sowed all seeds by hand, but that day is gone, and the men who could thus evenly distribute seed are dead. The best vehicles for sowing grass seeds are the fiddlebow seeder, the Cahoon seeder (these with winged discs that throw the seed far on either side, the man walking and turning the machine by hand) and the wheelbarrow seeder. The latter tool is possibly the better, assuredly the most accurate, though one can with care give good distribution with either of the machines. There are drills made for drilling in clover and alfalfa seeds; these work well

and save much seed, besides giving better stands than are commonly secured. These drills will also seed bluegrass and timothy quite well, though to do so the land should be very fine and smooth. An efficient leveler to precede a grass or clover seeding drill is made by taking two pieces of 2″x6″ stuff 8′ long, setting these on edge like the runners of a sled, spacing them to be parallel and 6′ or 8′ apart. Between these, connecting them at right angles, place 4 cross pieces of the same dimension stuff, each piece set on edge at the same level. This is drawn by a rather long hitch so that it drags earth with each of the 4 cross pieces (five may be provided) and each one deposits something in a low place and aids in scraping off the high places. A little weight may or may not be needed to make this leveler operate well, depending on the looseness of the soil. It pays well in sowing grass and clover seeds to have the land fine, firm and smooth.

Covering the Seed.—The lightest covering must be given to very small seeds such as bluegrass; other stronger seeds, such as timothy and brome grass, may be covered half an inch or more deep and yet find their way through. Ordinarily, if the seed is sown alone, a bush harrow may be used to good advantage, or a plank drag will rub the seed sufficiently into the earth. If the seed is sown with a nurse-crop it may be sown in front or behind the drill; if in front, some of it will be lost but commonly enough will be covered to a proper depth to give a stand.

Seeding with a Nurse-Crop.—In sowing grass seed in the fall it is the almost universal custom to use a nurse-

crop, commonly of wheat, winter barley or rye. The use of a nurse-crop is often an advantage, since it lessens the danger of the little seedlings being lifted out by the frost or buried by repeated thawings and freezings. Timothy sown alone on a good seedbed, well enriched, will come along better alone and make a fair crop of hay the next season. If sown with wheat it may be so far advanced as to struggle with the wheat for supremacy, so it is common in some sections to sow the timothy 10 days after the wheat to hold it in check. It is always better for the grasses if the nurse-crop is mown off early for hay, as sometimes when it is permitted to ripen grain it has so shaded the land and drained it of its moisture that the little seedling grasses are lost.

Seeding Clovers in the Spring.—Where grasses have been sown in the fall the clovers are commonly best added in the spring. Fall-sown clovers need early sowing in northern climes, though in the South they are best and may be sown as late as November in the Gulf States. Commonly in the regions where grass is grown clovers are added in spring. There are several methods of doing this. The easiest and perhaps most common is to sow on frozen ground at a time when the frost has honeycombed the land. This lets the seed sink down and become more or less covered. Others sow as early as February and trust to the freezing and thawing of winter to bury the seed. Yet others sow half their seed over the ground early and the remaining half after growth starts in the spring. It has been my experience that each way will succeed if the soil is right, though

there is always uncertainty more or less great in clover seeding on unprepared land. When one can do so without disturbing the grasses too much one should wait till the land is dry enough to work in April or late March, then harrow lightly and sow the clovers, perhaps harrowing again to cover the seed. With proper care this may be done with no resulting injury to the previous seeding, or so little injury that the good of having a sure stand of clovers much more than offsets it. One will need here to be in the field in person since one can not trust the harrowing of young grasses to ignorant and heedless laborers. It is common to use 10 pounds of clover seed which may be of purely red clover, or a mixture of red and other clovers. Always where there is suspicion that alfalfa may succeed one should sow in the mixture enough alfalfa seed to give a thin scattering of plants over the field, in order to inoculate the field and to show the condition of the soil in respect to sweetness, drainage and fertility, since there is no such soil barometer as the alfalfa plant. I have had fine success with a mixture of 6 pounds of red clover, 3 pounds of alsike and 1 pound of alfalfa, though this mixture may put too much alsike into the meadow, and the use of 2 pounds of the latter and 7 pounds of red clover, with 1 pound of alfalfa, may give a better result, this depending certainly on the nature of the land. If one desires, one can sow more alfalfa, but the small amount indicated will be enough to give a scattering stand for purposes of observation and inoculation. Sweet clover may be introduced into the mixture if the field is to be mown; animals do not graze this clover well when they may

get other grasses and clovers. If for pasture always add 2 to 4 pounds of white clover.

Seeding Grasses in the Spring.—If all the seeds are to be sown in the spring one should have the land plowed early as possible so that it may be well settled together. Much grass seed is lost because of too loose a seedbed in spring. Give all the harrowing that you can and work the land down to a thorough seedbed, yet hasten the work so as to get the seeding done as early as there is growing weather. Along the 40th parallel I like to sow grass seeds the first week in April; during some years March will be a better time, and farther south the work may be best done still earlier. I do not think that in spring the chances are very good of getting a stand of grasses having small seeds, such as bluegrass, unless one seeds quite early and on a good, fine, firm seedbed. Here again it is true that the more seed used the better the chance of success, since by their very multiplicity the seedlings protect one another. Here again comes in the helpful nurse-crop.

Nurse-Crops in Spring.—I advise always the use of a nurse-crop; that is, if the farmer can use one with judgment and discretion; if he cares only for the nurse-crop he had better seed the grasses alone. If he will sow one bushel to the acre of spring barley, preferably a short-strawed, strong variety that will not lodge, or 3 pecks of oats, if he will remorselessly cut the nurse-crop off for hay when in bloom, it will do good and no harm. If, on the other hand, he seeks to get a maximum crop of grain and a seeding of young grasses at the same spring sowing, he will very often get the grain and a

very unsatisfactory and uneven stand of grass. The thin seeding of a nurse-crop is a distinct help if it is taken away before it has exhausted the soil of moisture; if it is allowed to stand till the grain is ripened many of the young grass plants will have died.

A Sure Way to Get a Grass Stand.—In order to get a stand of these young grasses one must have the land firm, the shading weeds destroyed and the sun let in but not too strongly. The best success that I have ever had in seeding has been to sow early in spring with a nurse-crop of barley or oats, and as soon as the grasses and clovers and grain were well started turning in a flock of sheep and letting them graze it all down, but not close. As soon as it is well grazed down, which should be within a few days, the sheep are taken out and all allowed to start growth again. The sheep are turned in the second, and later the third, time, judgment being used to see that they do not gnaw the young clovers too. I have had no such stands in any other system of management as I have secured in this way. The little feet of the sheep seem to firm the land just right without overdoing it. The nibbling down of the oats or barley, the nipping off of the weeds, all seem to favor the young and springing grasses and clovers. After the nurse-crop has been disposed of finally in this manner, the sheep should be taken out for some months to let the young seeding get a brave start.

Use of a Roller.—The roller is an almost indispensable implement in getting a good stand of grass in the spring. The land must be made firm for little seedlings. Several types of rollers are in use. In general we may say

that a roller may easily be too heavy, especially in a moist season; that if the earth is moist the roller should not be used until it has dried somewhat, so that no packing or crusting will occur, and that it is often advantageous to roll the new seeding weeks or even months after sowing, should the land get dry and there be danger that the loose seedbed may dry out before the rootlets of the small grasses and clovers can reach permanent moisture below. I have often taken out a very heavy roller in midsummer and pressed down hard the young meadow, with excellent results. For such use a roller of concrete is very useful; it may be made to weigh a ton or more, and for use in dry weather the heavier it is, within reason, the better. The heavy roller is useful also as a pusher-in of small stones and sticks that might hurt the mower. One should own two rollers; one may be light for use in the spring and the other to use on old meadows or pastures much heavier.

Corrugated Rollers.—Rollers are made with corrugations having a rather sharp V-shaped edge. These are admirable for new seedings. The seeds pressed in by use of this roller are sure to be in part in moist, fit soil and the resultant stand is apt to be very good. This roller is not so well adapted to use on old-established meadows unless one is desirous of pushing in some fresh seed.

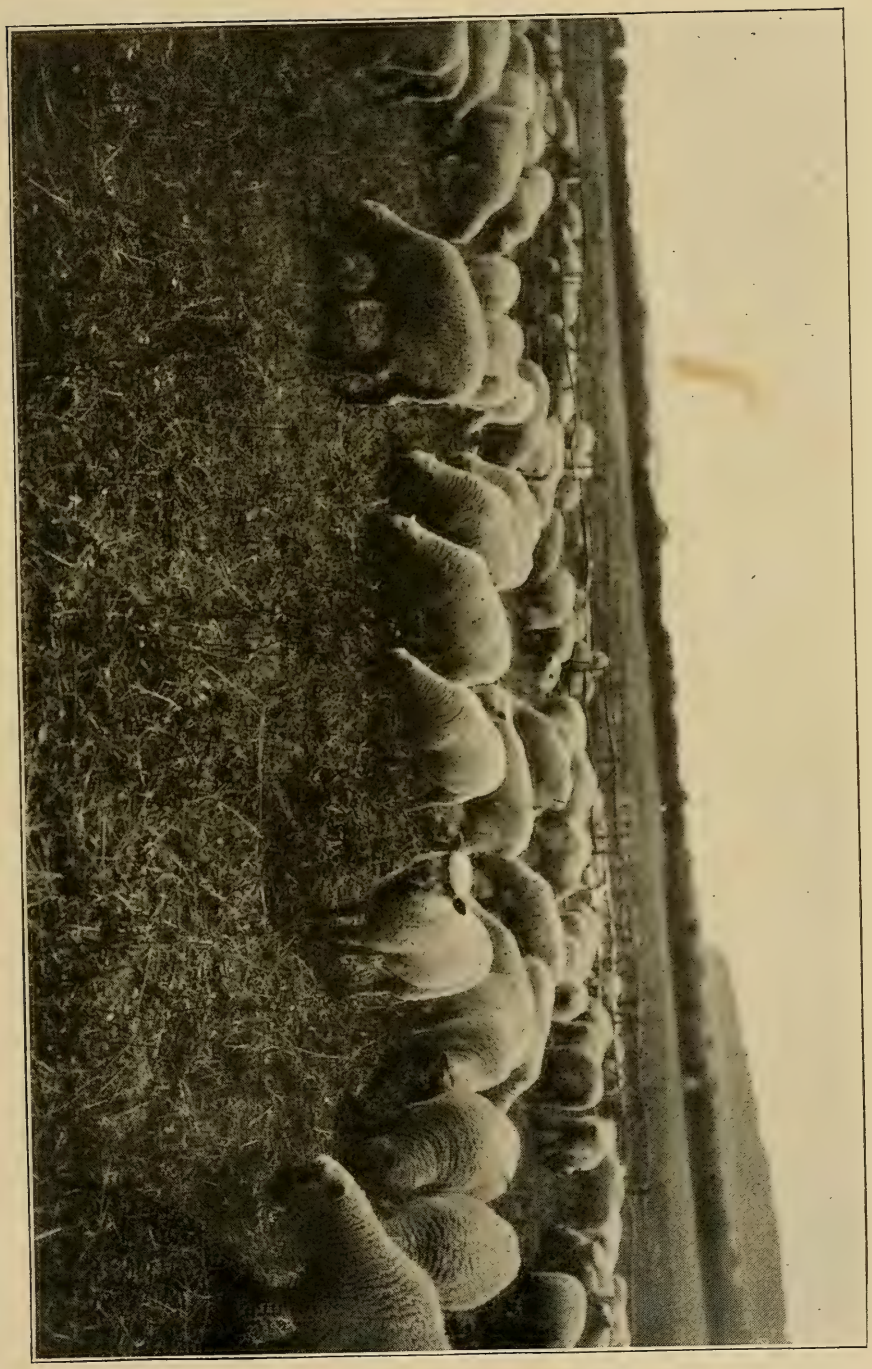
After-Care of Young Grasses and Clovers.—And when one has a stand, what? Consider that the young things are infants, and be gentle. If the land must be grazed take out the animals in wet weather. It takes time to establish a tough sod that will bear up the ani-

mals' feet. It is really better oftentimes to mow the new field for a year before animals are turned in. Weeds do great harm; mow them off or pull them. Watch to see that the clovers do not smother out the young grasses; cut them off before they can do this if danger there is. Commonly clovers do not smother, and alfalfa least of all, since it grows straight, and lodges less than red clover. Watch to see where feeding is needed and make mental note of these places, so that the manure spreader may go over them in the winter, lightly distributing stable manure, or if the grasses need immediate strengthening one may give them a dressing of 100 pounds of nitrate of soda and about 300 pounds of acid phosphate per acre, distributing these on the surface where rains will soon make their presence felt. Weeds, nurse-crop, a too loose seedbed, and starvation—these are the dangers to new seedings.

CARE AND MANAGEMENT OF MEADOWS AND PASTURES.

Some grasses seem benefited by hard grazing and much tramping. Bluegrass is one of these; if the land is loose the grass does not thrive as it will if it is packed by the feet of stock. There are other grasses that are much hurt by being tread upon; among these is timothy. Yet while bluegrass is the better for being tramped and grazed rather hard, it is wise management that takes off animals in wet weather of early spring, when the animals' feet poach hard the land and tramp it into cud. Such tramping is injurious.

Feeding on Pastures.—The thing most helpful to a pasture is to feed animals on it some rich feed, as cottonseed-meal, alfalfa hay, or, in fact, any ration that makes the animals thrive, though feeds rich in nitrogen add most to the value of the grass. English farmers know this well and buy our linseed meal or cake, and cottonseed cake as well, which they feed to bullocks and sheep on grass. They feed, also, our corn, but say that they do not see so much benefit to the land where corn has been fed as where cake has been fed, and this is but natural, since the cake is rich in nitrogen (derived from the protein of these feeds), while corn is rather deficient in protein. Assuredly feeding on pasture is the best method of making it good, and commonly profit is derived from the feeding operations as well. There is need of care that the feed troughs do not always remain in one spot and that the animals do not destroy the grasses by tramping it into mud during the wet time of the year. It is all too common in America to place feed troughs in the pasture or feedlots and leave them in one spot for years. Thus there is wasted, and much more than wasted, a great deal of manure, the net result of which for years will be the rank-growing jimpson weed and dog fennel. Feed troughs and racks should always be on runners so that horses can quickly move them from one spot to another and thus have the manure well distributed over the pasture. The yield of grass may in this manner be very much more than doubled, and it is doubtful whether there is any better way of recovering the fertility deposited by the cattle than by a wise management of pasture grasses to take it up.



Southdown Lambs in English Hurdles.

Effect of Manure on Permanent Pasture.—I have found nowhere any greater profit from the use of common farm manures than on old pastures, principally bluegrass. Commonly men do not have any means of knowing just what good they get from manure on pasture. In our lawn, which is newly taken in from an old bluegrass pasture, I applied in the winter of 1908 manure to one square rod of grass, giving it only a fairly liberal dressing, maybe at the rate of 10 tons to the acre. In 1909 I harvested the square rod with the scythe, and it yielded more than 125 pounds; in truth, the actual weight was 155 pounds, but as it was weighed a little damp I called it 125—much too little I feel; while the unmanured rod right alongside made a yield of 55 pounds, which I guessed at 40 pounds, allowing for the moisture of dew. These weights were at the rate of 3 1-5 tons and 10 tons to the acre. Thus the manure had made an increase per acre of 6 4-5 tons or about a ton of forage for a ton of manure. This was cut in May, so that there was nearly as much more growth during the summer and fall, which illustrates just how profitable bluegrass pasture may be. Ten tons of silage corn is considered a fair yield of forage. Is not 10 tons of green grass eaten off by good animals fully as likely to give profit? Consider, too, that to grow the acre of silage corn will cost at least $5 and to grow the acre of bluegrass mixed with white clover has cost only the manuring, which would be even more necessary in the case of the corn than in the case of grass. While the unmanured bluegrass, producing about 3 tons of green forage to the acre, might show a small profit, yet the point is to know how yields may be increased.

Mineral Manures on Pastures.—Lime is the bedrock of good grass pasture. After lime, comes the need of phosphorus and potassium. Most soils in the United States have in them now a good supply of potassium. The exceptional soils are those derived from peat and sandy lands. Peaty soils may be so deficient in potassium, though not all of them are, that the grasses growing on them will have little value. Sandy soils are more often in need of potassium, but on such soils pastures are, as yet, rarely established. Phosphorus is the substance more commonly needed in soils; in fact, there are few soils in the world that are as rich in this element as would be best for plants. The one region that I call to mind now that is not benefited by use of more phosphorus than is native to the soil is the bluegrass region of Kentucky. There are parts of this region that show about 5 per cent of phosphoric acid in its subsoil, and many small nodules of phosphatic rock are scattered through the earth within easy reach of plant roots. I have tested several forms of phosphorus on permanent pasture in Ohio, but unfortunately have no figures showing results. Apparently the best results were secured by a very liberal use of floats or finely-ground phosphatic rock distributed right over the thick sod of an old pasture. Of this substance nearly a ton to the acre was used (it costs about $8 per ton in large lots) and it is plain to see that the result has been a doubling of the grass and a great increase in the number of clovers in it, beside a distinct difference in color of the herbage. I applied also a sprinkling of stable manure, which complicates the situation, but I have no doubt that I will

recover much more than the cost of this phosphorus and that it will continue to return good results for many years. There is no fear of the phosphorus or floats being washed out of the soil; it becomes slowly available when in combination with decaying vegetable matter or in acid soil and is steadily buried in the land as earthworms bring up their casts and rains wash the floats down.

Bonemeal will do wonders to grass, as I have often seen, commonly where applied to lawns, but I regret that I have no figures of American practice showing the cost and results. Nor, though we have used it, have I any accurate data as to the result of acid phosphate on pasture land. I have, however, found it to increase the yield of alfalfa applied on meadows that were failing. There are now experiments being conducted in Missouri, Ohio, Virginia, and I hope other states, to determine the best use and profit resulting from the use of many substances on grass land, though as yet but meager results have become available.

Animals Graze Manured Grass Better.—"I do not object," remarked Josh Billings, "that folks know so much, but I do object that they know so many things that are not so." It is indeed annoying to learn how many of the common opinions held by mankind are erroneous, even when they are on such easily observable phenomena as pertain to farms. Nearly all farmers believe that manure put on pasture makes the grass coarse, rank and distasteful to animals. The reverse is true; manure on pasture makes the grass more appetizing and nutritious. This is true as to sheep and cows, and to an extent as to

horses. I have daily opportunity to witness how eagerly the cows and sheep nibble certain strips in a pasture nearby, where manure is thinly spread each year and where the grass grows thick and green. There are exceptions to this truth, however, and things well worth bearing in mind.

Excessive Horse Manure on Pastures.—It seems proved that it is dangerous to put large amounts of city manure on horse pastures, for though it may make a great growth of grass the grass seems sometimes to cause disease among the horses grazing it. In Virginia where men have bought farms and turned them into grazing land they have sometimes sought a quick short cut to good grass by the use of large amounts of manure shipped from cities. This manure would be nearly all made by horses. While the result in growth was very satisfactory, yet there developed quite frequently the disease called "pighead." Henry Fairfax, a very careful observer, related these facts to me, and further stated that he had cured a number of cases by simply taking them away from the excessively rich manured pastures and putting them on his own grass where little or no manure had ever been applied. I have observed that horses very unwillingly graze over or near their own droppings, nature seeming by instinct to direct them where it is safe and healthful to graze and away from the unsafe. Sheep and cattle graze readily on the spots neglected by horses.

Mixed Stocking of Pastures.—For many reasons it is wise to graze pastures either with a mixed company of cattle, horses and sheep, or else to alternate them, using

say the sheep first, following with cattle and later by horses, though the order of rotation is not so very essential. The first animals turned to the grass will take the cream from it. If the three classes of animals graze together there will be few weeds left uneaten and the grass will be cut down pretty evenly all over.

Do not put Sheep Manure on Sheep Pastures.—While all animals harbor parasites, sheep are more in danger from these scourges than other animals. There are various parasites that may develop in the grass, chief among them being the stomach worm, though tapeworms and the worm causing nodular disease cause much trouble and loss. These parasites all come from germs that pass out in the excrements and develop in the young springing grass. It is clear that grave danger to the flock lurks in any land manured with sheep manure and carrying grass. There is of course no danger that sheep parasites would attack horses, and small danger that they would attack cattle, though the stomach worm seems to find a host in calves at times and to cause considerable trouble. It is safe to put sheep manure where it will be plowed under for crops. There is no danger of infection from hay or other forage mowed from manured fields.

Foreign Experience in Feeding Pastures.—In the Old World men have long practiced the art of feeding and maintaining pasture lands. I was much interested to see that they not only fed their pastures, but they fed especially certain parts of them. For example, Ernest Perriot at Nogent-le-Rotrou in France showed me pastures that were never fertilized, being subject to overflow of the river Huisne, and other pastures that were fed in

parts and in other parts left unfed. There much reliance was placed on basic slag, which seemed to make the grass sweeter and more filled with clovers. James Peter in Gloucestershire, England, showed me pastures parts of which he fed and other parts that needed no feeding. His practice is to use 1,000 pounds of bonemeal once in 7 years, and annually a few hundred pounds of basic slag. He also feeds corn and cake to good cattle on grass, and the results are extraordinary, the thickness and richness of the grass being almost past belief. In England it is a common sight in spring to see manure distributors going over the fields putting on basic slag, mixed sometimes with a small amount of nitrate of soda. It is thought, however, that the slag should for best results be applied in the fall. In Scotland I observed the use of fertilizers on pasture, and the intelligent system of study by which the land was divided into a series of small pastures, each one given a different fertilization, and each lot stocked with sheep, careful account of which was kept so that one could know just which combination of fertilizers paid best. This work is new to us in America, but it seems assured that we shall soon come to it with the plowing up of pasture land in the West, and the consequent decrease in cattle stocks just at a time when meats are higher than ever before within our knowledge.

Fertilization an Art of Diversity.—It is no simple problem to take a given bit of land and ascertain just what sort of fertilization will best suit it. The problem will require a separate working out for each class of soils. Roughly, we may thus divide our soils and their

requirements: First the clays, deficient in limestone. These soils need carbonate of lime, and are benefited by phosphorus and manures. They rarely call for potassium. Second, clays having enough carbonate of lime already in their composition. These are our natural grasslands and are easiest made to grow good grasses. They respond to applications of phosphorus and sprinklings of manures. In our hot climate and under our burning suns we use up humus faster than they do in England, and so any sort of vegetable matter laid over the land is of great use, even to feed cornstalks and let them lie to decay will help grass on these heavy clays. On these limestone clays phosphorus and nitrogen are the deficient elements, but if the phosphorus is supplied commonly clovers will come in, or may be invited in, and will supply the nitrogen. Here one could use basic slag if one were near enough to the seashore to get it at a reasonable cost, since even on these soils there is seldom quite enough of carbonate of lime in the topsoil. Next may be placed sandy soils. These are helped by the use of carbonate of lime, phosphorus, potassium and the seeding in of clovers. Lastly come peaty lands, of which we have less than are found in the Old World; these are vastly helped by the use of potassium and phosphorus, but they do not usually need applications of nitrogen, as this element can be obtained by growing legumes.

Thus it will be seen that each man will have to feel his way in this work, testing one substance and another, feeling pretty sure, however, that phosphorus will always help, that the land that is not benefited by the use of stable manure is a curiosity in America; that

drainage is always a good thing, and that carbonate of lime sweetens grass and makes clovers thrive.

Fertilization of Timothy and the Crop Following.—Bulletin 273 of Cornell University Experiment Station, Ithaca, N. Y., is full of significant facts relating to the effect of fertilizers of various sorts and of farm manures on timothy and on the corn crop following. Briefly, the fertilizers applied were nearly all profitable in increasing the timothy crop alone, and the corn following showed marked results. By far the larger residual results were secured from the use of barnyard manure, 10 tons to the acre producing an increase of 110.3 per cent and 20 tons producing 115.1 per cent increase. The summary follows:

"This bulletin shows that both manure and artificial fertilizers have a marked residual effect. On plats 711-732, the average yields of the plats receiving fertilizers above the check plats show a gain of 35.8 per cent for forage, 25.15 per cent for stover, and 66.65 per cent for ear corn. In all cases the increase in ear corn was greater than that in forage or stover. When a single fertilizer was used, potassium increased the ear corn more than nitrogen or phosphorus. When two were used in combination, potassium and phosphorus gave the greatest increase in forage and stover, potassium and nitrogen in ear corn. The maximum increase in forage, ear corn and stover was obtained when all three fertilizers were added. (The previous year the same combination gave the highest yield of timothy.) The residual effect of barnyard manure was greater than that of any combination of artificial fertilizers. Ten tons per acre show an increase of 110 per cent in ear corn and 20 tons per acre an increase as high as 115 per cent. The increase in stover and forage, though not quite so high as in ear corn, was much greater than that of any combination of mineral fertilizers. The increase in yield of hay in 1905-06-07 was in every case worth more than the cost of fertilizers applied, so that the increase in yield of corn was clear gain. Figuring on the current market prices for the fer-

tilizers, and 50 cents per ton for farm manures, the use of 20 tons of farm manure applied twice to timothy but not used for corn, gave a gain of $108 per acre in four years. Ten tons of manure gave a gain of $72 per acre, and the most profitable combination of fertilizer constituents produced a gain of $60.85."

Lessons from the Old World.—Prof. Douglas A. Gilchrist of Armstrong College, Newcastle-Upon-Tyne, England, has made many experiments in fertilizing meadow and pasture land long laid down in the counties of Cumberland, Durham and Northumberland. In a bulletin on "Effect of Manures on Old Hay Land," issued in February, 1906, I find much of great interest and value. The soils operated, however, are some of them quite different from any commonly used in America, except that we have peaty soils in our northern states. The experiments found a most interesting change in the character of these old meadows consequent on fertilization, the use of basic slag bringing in the better species of grass and many clovers. Work of a similar nature, and equally significant in results, is under way at the Rothamsted Experiment Station at Harpenden, England, as reported by Director A. D. Hall. I quote thus from Prof. Gilchrist:

Effects of manures on herbage and soil nitrogen.—"From an analysis of the soil of the unmanured plot, it was seen to be of a very poor character. It contains 14 per cent of stones and nearly 6 per cent of poor, turfy, organic matter. It is remarkably poor in available phosphates and potash, and contains only 25 per cent of lime. This poorness in lime probably explains the greater effectiveness of basic slag than of superphosphate on this soil, and also the much worse results with sulphate of ammonia than with nitrate of soda. This has been demonstrated in a striking manner at Woburn. A student took samples of soil, 12″ square on the surface and 6″ deep. from four of the plots in July, 1905, and also collected the herbage

growing on each of the samples, and made a botanical analysis of them. Following are the results:

COMPOSITION OF HERBAGE (HAY).

Plot.	Manuring.	Legumes.	Grasses.	Weeds.	Weight of dry hay.
		Per cent.	Per cent.	Per cent.	Grams.
1	No manure	11.5	48.7	39.8	19.9
7	Slag and kainit	23.0	53.8	23.2	53.4
8	Nitrate, slag and kainit	19.3	59.8	20.9	49.3
9	Sulph. ammonia, slag and kainit	8.5	64.3	27.2	42.6

"On Plot 1 there was an abundance of plantain and field woodrush, while the grasses (chiefly bent and fescues) were poor and stunted, with no seed stalks, and the legumes were represented only by a little birdsfoot trefoil and white clover. Plot 7 had an abundant sole of white clover herbage, with some red clover and other legumes. The grasses were bent and fescues, with some Yorkshire fog and cocksfoot, the last being better developed here than on any other plot. There was much less white clover on Plot 8, and the plants were weak. Sweet vernal and crested dogstail were present, in addition to the grasses on the last plot, while plantain and yellow rattle were the principal weeds. On Plot 9 white clover was weaker than on Plot 8; fescues and bent were the chief grasses, with some sweet vernal, while plantain and field woodrush were the principal weeds.

NITROGEN IN THE HERBAGE, ROOTS AND SOIL OF DIFFERENT PLOTS.

Roots and soil to a depth of six inches.	Plot 1. No manure.	Plot 7. Slag and kainit.	Plot 8. Nitrate, slag and kainit.	Plot 9. Sulph. ammonia, slag and kainit.
	Per cent.	Per cent.	Per cent.	Per cent.
Nitrogen in herbage.	.013	.029	.031	.032
Nitrogen in roots	.039	.047	.044	.051
Nitrogen in soil	.107	.112	.103	.109

"The foregoing figures show that the soil is practically no richer in nitrogen on Plots 8 and 9, after the continuous application of either nitrate of soda or sulphate of ammonia for thirteen years,

than on Plot 1, the unmanured plot. Plot 7, however, continuously dressed with slag and kainit, but no nitrogen, for the same period, has now about 5 per cent more soil nitrogen in the surface 6″ of soil than in the same of the unmanured plot, and has also produced more than double the weight of hay. From the analysis of the hay it has been calculated that the hay removed annually from Plot 7 contained 18 pounds more nitrogen per acre than that removed from Plot 1, or as much nitrogen in 13 years as is contained in 13⅛ cwt. nitrate of soda. There is also an increase of .005 per cent nitrogen in the surface 6″ of soil of Plot 7 over that of Plot 1, which represents about 75 pounds of nitrogen an acre, the equivalent of nearly 5 cwt. of nitrate of soda. The slag and potash on Plot 7, therefore, have indirectly provided as much nitrogen per acre during the 13 years as is contained in about 18 cwt. of nitrate of soda, and this only takes into account the surface 6″ of soil. Here is, therefore, an excellent demonstration of how mineral manures (slag and kainit) may indirectly make use of nitrogen from the air by developing clovers and other leguminous plants. The amount of phosphates applied in the slag is double of that in the superphosphate; but in each case the quantity applied is probably about the right quantity for giving the best results. The lessons to be derived from these thorough and long-continued experiments on the manuring of old land hay are:

"On the heavier soils phosphatic manures are by far the most important, and of these basic slag is on the whole the most satisfactory. On the lighter soils basic slag alone is not likely to be effective, but when accompanied by a potash manure, excellent results are usually given. Too heavy dressings of superphosphate may do considerable harm on some soils. It will be seen when the results of several years are taken into account that neither nitrate of soda nor sulphate of ammonia is a desirable manure for old land hay. The weight of the crop will probably, in the long run, be less, while the quality will undoubtedly be poorer. This applies either to these manures used by themselves, or in combination with phosphates and potash. Slag only (on the heavier soils) or slag and a potash manure—say muriate of potash or kainit—usually develop clover and allied plants in a marked degree, and small annual dressings of these will continue this development of clover herbage, as is shown by many of the experiments. On the whole, neither ground lime nor common lime has given anything like profitable returns,

even several years after application; in fact, these experiments indicate that basic slag is really the best source of lime for this purpose, and that it owes its good effects to the lime as well as the phosphates that it contains. Half a ton of basic slag contains as much lime—partly free and partly in combination—as is contained in ¼ ton of ground lime. The fineness of grinding of the slag undoubtedly increases the effectiveness of the lime as well as of the phosphates it contains. It is, therefore, suggested that for most soils the use of basic slag makes the application of either common lime or ground lime unnecessary for old land hay or for pasture. It is only soils of a peaty character, or those with a good deal of rough, matty herbage, or some organic matter, that are likely to give a return from these forms of lime. Slag generally supplies the lime requirements of all except this class of soils with more profitable results. The results of some experiments elsewhere have indicated that lime added to slag diminishes the good effects of this latter manure.

"The nitrogen-collecting effects of slag, or of slag and a potash manure, are well illustrated by the results at Broomhaugh, where it is shown that the amount of nitrogen collected per acre in the surface 6″ of soil in 13 years together with that contained in the extra hay grown during that time, amounts to nearly as much as is contained in 1 ton of nitrate of soda. It is also evident that this natural supply of nitrogen has most beneficial effects in the soil, this being a marked contrast to the effects of active nitrogenous manures. The complex dressings of manures—containing dissolved bones, bonemeal, fish meal, slag, superphosphate, kainit, and a very little active nitrogen—have given excellent results on loam soils, but have not done so well on stiff clay. These results are worth close attention, as are also the uniformly good results with bonemeal and kainit when continued for 11 years at three centres. When an old land hayfield becomes matted with herbage on the surface, harrowing with heavy harrows at the time the manures are applied is of great benefit, to open up the surface. Tusser, in the sixteenth century, in his 'Five Hundred Points of Good Husbandry,' advises farmers as follows:

> 'In meadow or pasture (to grow the more fine),
> Let campers* be camping in any of thine.'

*Football players.

"This suggests that, when the turf of an old land hayfield becomes matted, it should be grazed for one year (or two if necessary) with *cattle** and that these should be heavily caked, which will, by the heavier stock kept, tread down the turf more thoroughly and so allow much finer hay being produced in future years. Dung gives excellent results on light sandy soils but is not profitable if applied to peaty soils, nor is it likely to be so on heavy clay soils. This manure develops coarse herbage and usually increases the weeds. To sum up, on soils in poor condition an initial dressing of ½ ton of slag, with, on the lighter soils, the addition of 2 cwt. muriate of potash or about 6 cwt. kainit, is likely to be useful. If, however, dung has been used on the lighter soils, the potash manure may not be necessary. For the after treatment of these soils, and for the general treatment of soils in better condition, the application of about 5 cwt. basic slag every three years (with the addition of 1 cwt. muriate of potash for light soils) is likely to be a good plan of manuring per acre for old land hay. On the lighter class of soils, 10 tons dung in addition at lengthy intervals should give excellent results, in which case the potash manure may be reduced. On soils rich in lime, superphosphate may be preferable to basic slag. If no dung is used, about 3 cwt. of fishmeal, or other manure containing organic nitrogen, applied every three years, is likely to be a useful addition. The excellent results already obtained on a pasture field by feeding Bombay cotton cake, or other cake, on poor pasture which has already been improved by basic slag, indicates that the best nitrogenous dressing for old land hay is to graze it for one or two years and to feed cake to the stock. Basic slag and the potash manures will give the best effects if applied early in the winter. The distribution of all the manures must be perfect and they should be well harrowed in, especially if the herbage is at all coarse and benty. The improvement of large areas of poor clay pasture in the north of England can be commenced by a dressing of 7 to 10 cwt. an acre of basic slag, followed up by the regular feeding of cake to the grazing stock. It is desirable that tufty pasture should be mown before applying the slag. The lighter soils in pasture lying on the sand-

* Sheep and especially horses are not good for this purpose.

The aftermath of an old land hay crop should always be eaten down and it is an excellent practice to feed cake to the cattle while doing so. On old pasture, which has become very coarse with the growth of plants like heather, this heavy treading is essential.

stone rocks of the Mountain Limestone and the Millstone Grit, and other light soils poor in lime, may be effectually improved by the foregoing treatment, with the addition of, say 2 cwt. of muriate of potash to the slag. For the after treatment of these pastures, and for the general treatment of those in better condition, the same manuring as is outlined for the manuring of old land hay may be followed. Dung, however, is not likely to give as good results for pasture as for hay-making purposes, but it should be noted that dung greatly assists the formation of a sward on thin pasture soils which have been recently laid down. When limestone is the underlying rock, superphosphate may be more useful than slag, while the feeding of cake will also be useful. The same remarks apply to lime as have been made in connection with old land hay."

Example of Pasture Improvement in England.—In Bulletin No. 8 of the County of Northumberland Education Committee, Prof. Douglas A. Gilchrist presents the results of pasture experiments running from 1897 to 1905. This collection of data is so strikingly useful in giving a basis on which to work and something from which to plan work of our own, that I present the greater part of it. I regret that the sheep pastured were all wethers, since it may be that ewes with lambs would have shown greater gains. It is significant, however, that one may expect from pasturing wethers during the summer season (the reader will find by table the varying lengths) gains of from nothing (on unfed pasture) to 152 pounds per acre where the pasture has had liberal treatment—which in this instance meant cake (cottonseed) fed on the grass—and in one instance 163 pounds where basic slag was used. While these results seem somewhat small yet it must be conceded that here a gain of 100 pounds per acre from pasturing would net at least $5 more rental for the land, and with our fresher soils

of greater natural fertility than I assume this field to have had, we should reach that gain or more. Returns from pastures in Great Britain are, in many cases, of eye-opening character to an American. I have changed the values into American terms:

"*Manures for pasture in Tree Field.*—This report deals with the complete results of the Tree Field experiments for the nine years 1897-1905. A slightly modified scheme of treatment was begun in 1906. The field extends to about 34 acres, and is divided into 11 plots, each 3 1/20 acres in area. While experiments on crops admit of testing the comparative results by the weight of crops produced, this cannot be done with pasture. The results of these experiments have, therefore, been gauged by the increases in fasted live-weight of the sheep on the various plots. The average prices of several years indicated that about 7½c. a lb. was a fair figure at which to value the increase in live weight of the sheep. Of course this must have a higher value on the better than on the poorer plots, but granted that this is so the results arrived at would simply be accentuated. In arriving at the final results, the increase in live weight on the untreated plot is deducted from the same on the other plots, and the value of this per acre has deducted from it the average annual cost of the dressing. The result is the net annual gain or loss resulting from each of the dressings. Each plot has been treated differently, and has been stocked each year with a suitable number of sheep. These have always been carefully selected, and graded at the beginning of each season so that each plot might have sheep of the same average quality; and they have been all regularly weighed every four weeks during each season, having previously been fasted. Cross-bred wethers were purchased in the spring for the first three years, and half-bred wethers in the second three years, while for the last three years the stock has been mainly half-bred and three-parts-bred wethers. The grazing periods have been as follows: 1897, June 21-Oct. 11; 1898, May 16-Oct. 3; 1899, May 4-Sept. 21; 1900, May 23-Oct. 10; 1901, May 10-Sept. 27; 1902, May 20-Oct. 7; 1903, May 15-Oct. 2; 1904, May 17-Sept. 6; 1905, June 5-Sept. 25. The first and the last two periods extended to 16 weeks, and the remainder to 20 weeks. As the last four weeks always gave very low increases in the longer periods, a reversion was made to the shorter

in the last two years. The numbers of sheep per plot have varied according to the quality of the pasture, and have been as follows:

Plots	1	2	3	4	5	6	7	8	9	10	11
1897	8	8	8	8	8	8	8	8	8	8	—
1898*	10*	8	10*	8	8	6	8*	8	8*	8*	—
1899	8	6	12	8	8	6	8	8	8	8	—
1900†	8	6	9†	9†	9	6	9	9	9	9	8
1901‡	6	6	9	9	9	4	9	9‡	9	9	9‡
1902	5	6	9	9	9	4	9	10	8	9	12
1903	11	5	9	10	9	4	9	10	8	9	10
1904	12	5	9	9	8	4	9	9	8	9	9
1905	9	5	8	9	7	4	9	9	6	7	9

"The live weight gains per sheep per week have been of great assistance as a guide in stocking the plots, as whenever these became unduly high more stock was required, and vice versa. Following is a statement of these for the nine seasons:

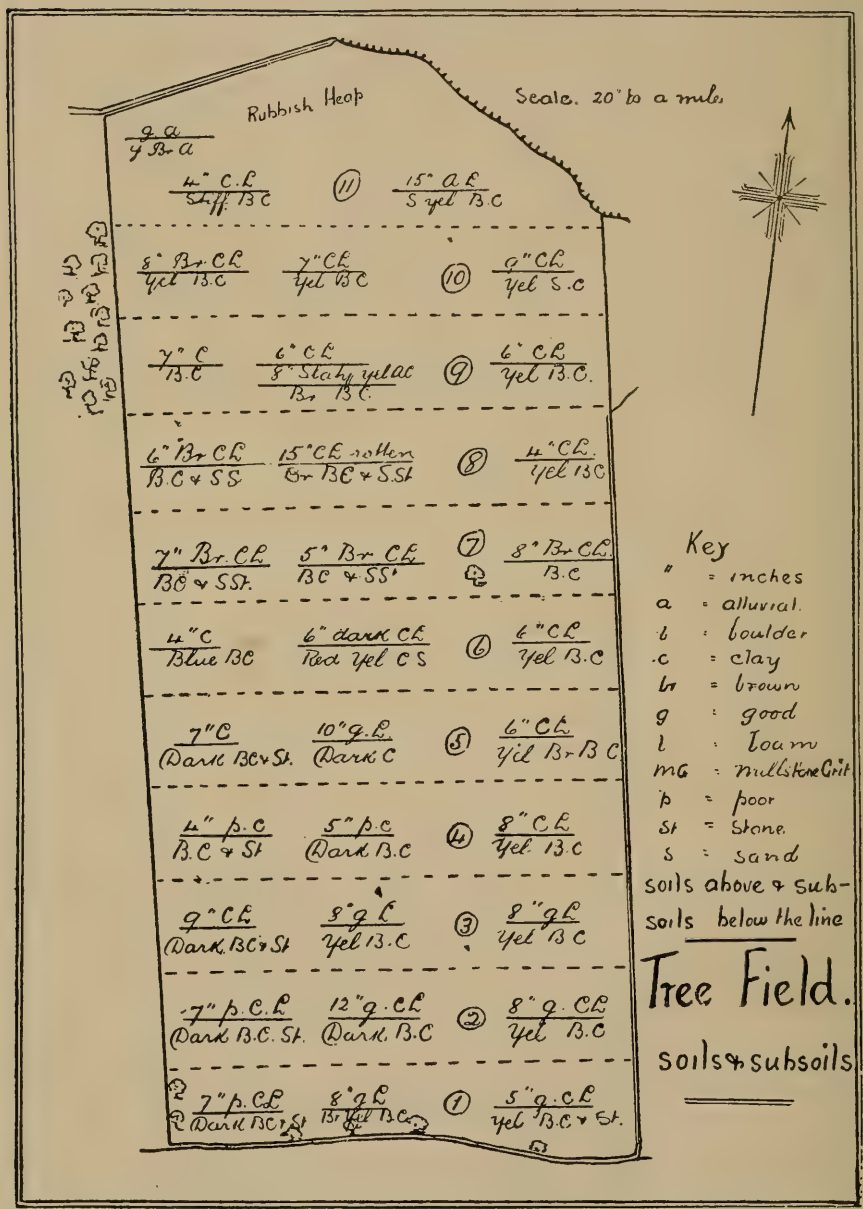
Plots	1	2	3	4	5	6	7	8	9	10	11
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
1897	1.9	0.7	1.8	1.0	1.3	0.9	1.7	1.6	1.8	1.4	—
1898	2.0	1.2	2.2	2.1	1.9	1.3	2.1	2.2	1.5	1.9	1.6
1899	2.0	1.1	2.6	2.1	1.9	1.2	2.0	2.1	2.0	2.0	1.3
1900	1.5	1.5	1.7	2.2	2.3	1.1	2.3	2.4	2.1	2.2	2.1
1901	1.3	1.0	1.7	1.8	1.9	0.9	1.9	1.9	1.6	1.7	1.8
1902	2.1	1.7	2.1	2.4	2.1	1.5	2.3	2.5	2.2	2.3	2.3
1903	2.6	1.4	1.7	1.8	1.5	1.5	1.7	1.8	1.9	1.8	1.7
1904	2.8	1.9	1.7	1.9	1.8	1.5	1.9	2.0	1.4	1.6	2.2
1905	1.0	1.2	1.0	1.1	0.9	0.6	0.9	1.2	0.9	1.1	1.2

"The soil is a poor stiff clay lying on boulder clay. The diagram shows the character of the soil and subsoil throughout. This has been extracted from a complete soil map, which has been prepared from notes made during a careful soil survey of the farm. In making this, holes were dug at suitable distances apart and full notes made of the characters of the soils and subsoils, every care being taken to dig the holes in such positions as would show the average depths of the soil, and expose good sections of the soil and subsoil. From the diagram it will be seen that the soil is of almost even char-

* On June 27 Plots 1 and 7 had one added; and Plots 3, 9, and 10, two added.

† On June 20 Plot 3 had three added; on July 18 Plot 4 had one added, and Plot 8 had two added.

‡ On June 8 Plot 8 had three added; on July 13 Plot 11 had three added.


Rubbish Heap
Scale. 20" to a mile.
g a / y Br a
4" C.L / Stiff B C
11
15" a L / S yel B.C
8" Br CL / Yel B.C
7" CL / Yel B C
10
9" CL / Yel S.C
7" C / B.C
6" CL / 8" Stiff yel a C / Br B C.
9
6" CL / Yel B.C.
6" Br CL / B.C & S S
15" CL rotten / Br B C & S.St
8
4" CL / Yel B C
7" Br. CL / B C & S St.
5" Br CL / B C & S S'
7
8" Br CL / B.C
4" C / Blue B C
6" dark CL / Red Yel C S
6
4" CL / Yel B.C
7" C / Dark B C & St.
10" g.L / Dark C
5
6" CL / Yel Br B C
4" p.C / B.C & St
5" p.C / Dark B.C
4
8" CL / Yel B.C
9" CL / Dark B C & St
8" g L / Yel B.C
3
8" gL / Yel B C
7" p.C.L / Dark B.C. St.
12" g.CL / Dark B.C
2
8" g. CL / Yel B.C
7" p.CL / Dark B C & St
8" g L / Br Yel B C
1
5" g.CL / Yel B.C & St.
Key
" = inches
a = alluvial.
b = boulder
c = clay
br = brown
g = good
l = loam
mG = millstone Grit
p = poor
St = Stone.
S = sand
soils above & subsoils below the line
Tree Field.
soils & subsoils

acter throughout, except for the variations on Plot 11, which are there indicated. This last plot is sheltered by trees on its northern and western boundaries, which also renders it not quite comparable with the others. Generally speaking the soil of the field varies from 4″ to 12″ in depth, is a poor clay and clay loam throughout, and is practically all lying on a subsoil of poor yellow boulder clay. Of the 706,000 acres under crops and pasture in the County of Northumberland, there are over 400,000 acres lying on this boulder clay subsoil, so that the Tree Field results are of great value as a guide to the manuring of the bulk of the pastures of the county. That Tree Field has one of the poorest of this class of soils may be judged from the fact that Cockle Park has not since 1829 been let at more than $3.60 an acre, and that this field is one of the poorest on the farm, and has at no time been worth more than $2.40 an acre. It was under cultivation and grew wheat crops frequently till about 40 years ago, since when it has been lying under pasture, which before 1897 was poor and benty and worth only about $0.60 an acre. The soil has been analyzed by Mr. Collins, who found it to contain .2 per cent nitrogen, .07 per cent phosphoric acid, and .5 per cent potash. There was soluble in a 1 per cent solution of citric acid, .005 per cent of phosphoric acid and .013 per cent of potash. It also contained .69 per cent of lime (CaO). For the last five years this Plot (Plot 6, untreated) has been stocked with four sheep, but it had a larger number in the previous years. The average gain in live weight per acre per annum has been 37 1/9 pounds, which at 7½c. a pound is equal to $2.78 an acre. Live weight increase, however, is not worth nearly as much from this plot as from the plots which have been improved by treatment, so that the real returns are considerably less than the above. In five of the nine years the sheep on this plot were worth less at the end than at the beginning of the season. On Plot 3, 10 cwt. slag applied for 1897 has at a gross cost of $5.44 given an average annual gain of $5.34 for the nine years, a marvelous return from this single dressing. It had the greatest effect in the third season after its application (when it gave 163 pounds per acre of live weight increase, worth about $12.24) and even in the ninth season afterwards has given 33 pounds of live weight increase, worth about $2.44 an acre. Clover development was greatest in the second year (about 20 per cent of the herbage). The poor bent grass has been greatly reduced. The soil has been improved in texture and darkened in color to a marvelous

extent on this plot, and on all the plots where clover development has taken place.

"On Plot 4, 10 cwt. slag, half applied for 1897 and half for 1900,

MANURES FOR PASTURE IN TREE FIELD. RESULTS PER ACRE FOR NINE SEASONS, 1897–1905. PLOTS 3 1-20 ACRES IN AREA.

Plot	Treatment and its total cost for nine years, 1897–1905.		Average of nine years, 1897–1905.			
	Treatment.	Cost.	Hay.	Live weight increase per sheep over plot 6. Amount.	Live weight increase per sheep over plot 6. Value at $.075 a lb.	Annual gain or loss (—)
			Cwt.	Lbs.		
1	Dec. cotton cake fed on plot, total of 597 lbs. 1897–8, again 1903, and again 1904*	$27.84	19½	69 5=9	$5.22	$2.14
2	Common lime, 4 tons 1897, and again 1903	24.00	12½	12 5=9	.94	—1.74
3	Basic slag, 10 cwt. 1897	5.44	25	79 8=9	5.98	5.34
4	Basic slag, 5 cwt. 1897, and again 1900	5.44	20½	66	4.96	4.32
5	Superphosphate, 28%, 7 cwt. (100 lbs. phos. acid) 1897, and again 1900	8.64	16½	57	6.26	3.30
6	Untreated throughout	.....	8½	.....	.....	....
7	Supers. as on plot 5; and sulph. potash, 100 lbs. 1897, again 1899, and again 1903	14.88	17⅔	65 7=9	4.94	3.28
8	Supers. as on plot 5; and ground lime, 10 cwt. 1897, again 1909, and again 1903	16.80	20⅔	79 1=9	5.94	4.08
9	Supers. as on plot 5; and sulph. am., 84 lbs. (17 lbs. N.) 1897, again 1899, again 1900, again 1903.	18.00	20	54	4.06	2.06
10	Diss. bones, 6 cwt. (100 lbs. phos. ac. and 17 lbs. N.) 1897, and again 1900†	15.84	20	61 1=3	4.62	2.86

* Each lot of cake contained 42 lbs. nitrogen and (assumed) 18 lbs. phos. acid and 9 lbs. potash.

† Plot 10 has received half the total amount of nitrogen applied to plot 9.

5 cwt. slag contains 100 lbs. phosphoric acid. 100 lbs. sulphate of potash contain 50 lbs. potash. Dissolved bones, 1906, contain 100 lbs. phosphoric acid and 22.8 lbs. nitrogen. 142 lbs. nitrate of soda contain 22.8 lbs. nitrogen.

The cost of manures per ton was as follows: Basic slag, $11.43; superphosphate, $12.65.; sulphate of potash, $47.20; sulphate of ammonia, $63.26; dissolved bones, $26.76. Decorticated cotton cake cost $35.28; common lime, $3.04, and ground lime, $4.87.

has not been quite so effective, the average annual net gain for the nine years being reduced from $5.34 to $4.32. It is evident that the application of this amount of slag in a single dressing is likely to give the best result in commencing the improvement of poor pasture of this character; 10 cwt. slag gave 321 pounds live weight increase per acre in the first three years after its application, whereas 5 cwt. slag gave only 132 pounds in the same time, considerably less than half of the larger dressing. That a second application of slag may be most effective is shown by the fact that for three years after the first application of 5 cwt. slag the live weight increase amounted to 132 pounds, while the same for three years after the second application amounted to 284 pounds. The second application therefore more than doubled the results. In the ninth season Plot 4 has given an increase of 41 pounds in live weight per acre, as compared with

LIVE WEIGHT INCREASES IN SHEEP PER ACRE, 1897–1905

	Total on plot 6.	Over plot 6 (untreated throughout) on plots 1	2	3	4	5	7	8	9	10	11
1897	37	43	—5	40	7	19	35	32	42	22	—
1898	53	91	11	118	60	51	68	66	41	64	—
1899	48	58	—1	163	65	55	59	66	61	58	—
1900	44	36	16	87	95	93	93	115	84	90	45
1901	23	28	18	82	84	92	90	121	75	77	108
1902	41	30	27	86	105	86	94	123	79	98	144
1903	41	152	7	58	76	50	62	79	58	68	70
1904	33	152	20	52	61	45	59	65	31	46	73
1905	14	36	20	33	41	22	32	46	15	30	44
Total	334	626	113	719	594	513	592	713	486	553	484
Average annual	37 1-9	69 5-9	12 5-9	79 8-9	66	57	65 7-9	79 2-9	54	61 4-9	80⅔

33 pounds on Plot 3, which shows that although the net gain has been the greater after the single dressing of slag, the unexhausted residue is now the greater where half of it was withheld till three years later. 5 cwt. slag increased *the proportion* (not total amount) of clovers to the same extent in the first three years as did 10 cwt., while in the first year after the second application of 5 cwt. slag, the clovers amount to 32 per cent, and even in the ninth year (or sixth after the second application of slag) to 17 per cent. While therefore the results on this plot have not been quite so good as on Plot 3 the clover development has been greater and much better maintained.

"The following figures show the comparative effects of 15 cwt. slag on Plot 11, and 10 cwt. slag on Plot 3 for six years after application, the former having been applied for 1900, and the latter for 1897. (Plot 11 was started three years later than the others and its results therefore are not included in the table). The better results given by 10 cwt. slag may be partly accounted for by the fact that while 10 cwt. slag developed 20 per cent of clover two years after its application, 15 cwt. increased it to over 35 per cent, but Yorkshire fog was developed to the extent of nearly 50 per cent four years after the heavier dressing of slag, whereas it increased in the same time to less than 20 per cent by the lighter dressing. This large amount of fog is the likely cause of the smaller returns from the heavier dressing of slag in the later years.

LIVE-WEIGHT INCREASES IN POUND PER ACRE (OVER PLOT 6).

	15 cwt. slag.	10 cwt. slag.
First year	45	40
Second year	108	118
Third year	144	163
Fourth year	70	87
Fifth year	73	82
Sixth year	44	86
Total	484	576
Average	80⅔	96

"The soil of Plot 11 is more variable in character than that of the other plots, and there were slight differences in the treatment of this plot in the earlier years, but the fact that the results here were probably the same as those on the untreated plot for three years before the application of the slag, renders the foregoing results fairly reliable. Plot 5 had 7 cwt. superphosphate per acre applied for 1897 and the same for 1900. This contained the same amount of phosphoric acid and was applied at the same times as the two dressings of slag on Plot 4. In the first three years superphosphate gave a total live weight increase of 125 pounds as compared with 132 pounds from slag similarly applied on Plot 4. Super-

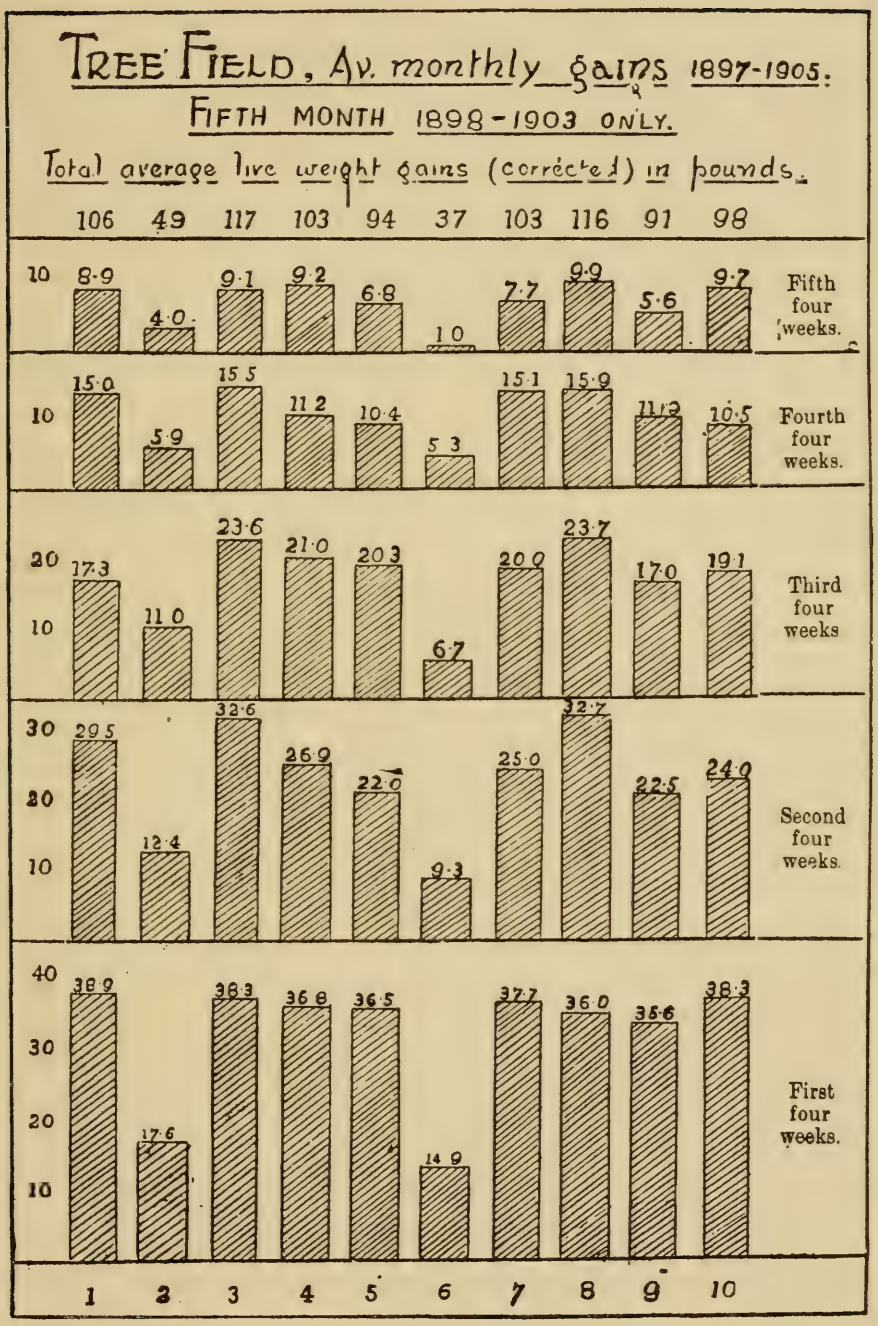
phosphate gave the better result in the first year but a poorer in the last two years. The second application of superphosphate gave 271 pounds increase in live weight in the three years after the second dressing had been applied, as compared with 284 pounds by slag in that period. That this manure becomes more quickly exhausted than slag is shown by its giving only 22 pounds live weight increase per acre in the ninth season (sixth after the second application) whereas slag gave 41 pounds in the same year. The net gain from this plot was $3.30 per acre annually as compared with $4.32 from slag similarly applied. With one year's exception (1900) clover has not been so well developed on this plot, but at the same time the clover increase has been of a satisfactory character, and has been well maintained till the ninth year. Plot 10 had 6 cwt. dissolved bones in 1897 and the same in 1900. These contained the same amount of phosphoric acid as the superphosphate for Plot 5, and in addition the former contained 34 pounds nitrogen in the two dressings. The sheep have increased in liveweight 4½ pounds more per acre annually on this plot than where superphosphate was used, but owing to the less cost of the latter manure the net gain per acre annually on this plot is only $2.86 an acre as compared with $3.30 from superphosphate. The results also show that the lasting effects of dissolved bones correspond very closely to that of superphosphate. Both these manures gave their best effects more quickly than slag, but did not give such good results in the later years. Dissolved bones have not retained clovers so well in the later years as superphosphate.

"Plot 8 has had the same superphosphate as Plot 5, and in addition 100 pounds sulphate of potash for each of the years 1897, 1899 and 1903. The result has been an average increase per acre annually of nearly 9 pounds live weight over Plot 5, which has just paid the cost of the potash manure, but has given no increase in the net profit. It is rather striking that the potash manure has not at all increased the clover plants, as there have been fewer of these here than on Plot 5, where superphosphate only was used. There is evidently nearly sufficient potash in this clay soil to supply the pasture requirements, at any rate for a considerable time. Plot 9 received the same superphosphate as Plot 5, and in addition ¾ cwt. sulphate of ammonia for each of the years 1897, 1899, 1900 and 1903. As a result the average annual increase in live weight has been reduced by 3 pounds an

acre, and the net gain per annum from $3.30 to $2.06 an acre. In the four years that sulphate of ammonia was applied the live weight increase was greater by 7 pounds per acre per annum, but in the five years this manure was not used the average decrease was 13¾ pounds (= $2.42 per acre per annum). Here we have a clear demonstration of bad after-effects of this manure on pasture, and a striking evidence against this manure having any residual value after the first year it is applied to pasture, showing on the contrary that compensation is needed for its bad after-effects. This manure has on the average slightly repressed the clover.

"Plot 2 had 4 tons lime per acre for 1897, and another 4 tons for 1903. The increase in live weight of the sheep has been only 12½ pounds per acre annually, and when the cost of the lime is deducted, the net loss has been $1.74 per acre per annum. On this poor exhausted soil (especially poor in available phosphates) there has not been sufficient plant food on which the lime could exert its beneficial action. Nor has the lime sweetened the coarse natural herbage to any extent, as sedges and mosses are still nearly as abundant here as on the untreated plot, while clover development has been very slight. Plot 8 has had the same superphosphate as Plot 4, and in addition 10 cwt. ground lime in each of the years 1897, 1899 and 1903. This addition of lime has increased the live weight of the sheep per acre per annum by 22¼ pounds, and the average annual net gain from $3.30 to $4.08 per acre. The live weight increases due to the addition of lime have been about the same for the first, second and third years after each application. The average annual increase in live weight from this plot is practically the same (about 79 pounds) as that from 10 cwt. slag all applied in 1897 (Plot 3), these being the two plots that have given considerably the highest increases. The greater cost of the superphosphate and lime than of the slag accounts for the considerably less net gain from the former. The results on Plots 3 and 8 show that a combination of superphosphate and lime has given very similar results to slag, and indicate that the lime present in slag is a valuable ingredient. Lime and superphosphate have developed clovers on this plot to practically the same extent as slag on Plot 4, and considerably more than superphosphate has done on Plot. 5.

"On Plot 1 about 600 pounds per acre of decorticated cotton cake have been fed to the sheep in the two years 1897-8, while 600 pounds


TREE FIELD, Av. monthly gains 1897-1905.
FIFTH MONTH 1898-1903 ONLY.
Total average live weight gains (corrected) in pounds.
106 49 117 103 94 37 103 116 91 98
10 8·9 4·0 9·1 9·2 6·8 1·0 7·7 9·9 5·6 9·7
Fifth four weeks.
10 15·0 5·9 15·5 11·2 10·4 5·3 15·1 15·9 11·2 10·5
Fourth four weeks.
20 10 17·3 11·0 23·6 21·0 20·3 6·7 20·0 23·7 17·0 19·1
Third four weeks
30 20 10 29·5 12·4 32·6 26·9 22·0 9·3 25·0 32·7 22·5 24·0
Second four weeks.
40 30 20 10 38·9 17·6 38·3 36·8 36·5 14·9 37·7 36·0 35·6 38·3
First four weeks.
1 2 3 4 5 6 7 8 9 10

were also fed to them in each of the years 1903 and 1904. The result has been an increase of 69½ pounds in live weight per acre annually and a net gain of $2.14 per acre per annum. Taking the two years 1897-8 as one for this purpose, the cake in the years in which it was fed gave an average increase of 146 pounds in live weight per acre per annum, which is equal to $10.94 at 3½c. a pound. As each 600 pounds of cake cost about $9.28 this left a gain of $1.66 an acre from feeding the cake in each of these years. In the five years that cake was not fed on this plot the average live weight increase per acre was about 37½ pounds, equal to about $2.80 in value, a most satisfactory result. There is no doubt that the extra treading of the pasture, by the heavier stock in the years that the cake was fed, has assisted the manurial ingredients of the cake, passed through the sheep to the land, in improving the pasture. The good effects of the cake fed in 1897-8 were well maintained for four years thereafter, as even the fourth season after the cake was stopped there were 30 pounds an acre of live weight increase, worth just over $1.92. The results in 1905, however, were not up to expectation as only 36 pounds increase in live weight were given, although cake had been fed for the two previous years. For every shilling spent on treatment the following returns have been given: By slag on Plot 3, $2.28; by same on Plot 4, $1.90; by superphosphate on Plot 5, $1.06; by same and potash on Plot 7, $0.72; by same and ground lime on Plot 8, $0.76; by same and sulphate of ammonia on Plot 9, $0.48; by dissolved bones on Plot 10, $0.62; by lime on Plot 2, $0.16 (loss); and by cake fed on Plot 1, $0.40.

"The Tree Field average monthly and average annual gains calculated per acre per annum, are shown in the diagram. The best results were given in the earlier periods of the season, and were comparatively small in the last periods (each of four weeks) when grazing was continued for twenty weeks. The climatic conditions make the average grazing season quite a short one. The good results of slag (Plots 3 and 4), and of superphosphate and lime (Plot 8) stand out in a striking manner. Cake fed on Plot 1 also shows well, but lime only on Plot 2, contrasted with Plot 6, shows little improvement over this the untreated plot."

There follow very interesting accounts of the effect of the various fertilizers on the composition of the herbage. Briefly, it was seen that any sort of fertilization

decreased the weeds and increased the useful plants, grasses and clovers; that basic slag increased the clovers about 20 per cent and some years up to 35 per cent, while weeds were much reduced, and that the plot having 1,500 pounds of slag resulted in the cleanest pasture fullest of grasses and with most clovers. Lime added to superphosphate resulted in the most clovers of any plot and here also weeds were most effectually repressed. Lime alone slightly increased the clovers but had little effect on weeds. The feeding of cake increased the grasses and repressed the weeds. It was found that orchard grass was increased where basic slag was used and to a less extent by bonemeal and superphosphate. Sheep fescue was increased by ground lime and superphosphate and by cake feeding. As the sheep were taken off at the end of summer there was left grass to be grazed by cattle. Calling the keep of a cow worth 24 cents, the plots produced yearly revenues varying from 64 cents on the untreated plot to $1.36 on Plot 3, $1.20 on Plots 4 and 9, $1.02 on Plot 10, $1 on Plot 1, $1.08 on Plot 8, 86 cents on Plot 2, 96 cents on Plot 5, $1.02 on Plot 7.

SUMMARY OF FERTILIZATION.

Grasses take from the soil available nitrogen, thrive especially well in soils rich in nitrogen, and need also phosphorus, potassium and lime. Most American soils contain enough potassium, so the need comes down to lime, phosphorus and nitrogen. Grasses can not get nitrogen from the air, while clovers can. When the conditions are right for clovers and they are well estab-

lished, they aid grasses, since they furnish available nitrogen to the land. Clovers revel in a soil well drained, somewhat alkaline rather than acid (this is brought about by carbonate of lime) and well supplied with phosphorus and potassium. The way, then, to secure nitrogen in the meadow or pasture is to get clovers growing in association with grasses, or to use fertilizers rich in nitrogen. Nitrate of soda applied to the grass meadow in spring after growth has started is an efficient carrier of nitrogen. It should be mixed with acid phosphate or some other carrier of phosphorus. Wheeler and Adams of the Rhode Island station recommend for their soils in timothy meadow an annual top-dressing of 400 to 500 pounds of acid phosphate, 300 to 350 pounds of nitrate of soda, and 300 to 350 pounds of muriate of potash. Leaving out the potassium for soils not deficient in this element, these proportions would doubtless serve well anywhere. Commonly 200 pounds of nitrate of soda to the acre is termed a liberal use. Winter top-dressing of meadows with manure is effective. The fertilization of pastures is yet on trial, the principle involved being to make the land sweet, encourage clovers, supply phosphorus and other elements when needed. Profitable results in most instances will result from the use of basic slag, bonemeal or carbonate of lime and acid phosphate. It pays well to spread barnyard manures evenly and with moderate thinness over pasture land. The feeding of concentrated feeds to cattle on grass gives perhaps the best results of any, and rightly managed the gain is clear.

The first step in the improvement of pastures is to

drain them. Liming with ground limestone may follow if the soil is lime-deficient. Apparently the use of floats or fine-ground phosphatic rock in large amounts is effective through a series of years. If one is in haste to improve a pasture first correct soil acidity with lime carbonate and disk the surface enough to loosen it somewhat without destroying the grass. Then fertilize with 500 pounds to the acre of bonemeal, or with 400 pounds of acid phosphate and 100 to 200 pounds of nitrate of soda, or use the phosphate or bonemeal alone and sow over the land fresh seed, mainly of red and white clovers, say 4 pounds of red and 2 pounds of white per acre (less will often serve well) and again harrow to cover the seed. This should be done in early spring. It will cost something thus to fertilize a pasture, but it is doubtful whether any outlay on the farm will return better profit.

MANAGEMENT OF PASTURES.

It is commonly assumed that a shaded pasture is best for grazing animals, and that shade may have some value in preventing sunburning of grass. These beliefs are fallacious. Animals graze best in pastures with little or no shade, and the grass suffers sooner from drouth under trees than in the open sunlight. Tree roots are vigorous feeders and absorb moisture and fertility more rapidly than can grass roots. There is but one tree which will, to my knowledge, benefit the pasture land as pasture, and that is the black locust, which, being a legume, enriches the soil. It is not worth while to fertilize grass growing under trees of dense shade; in spreading manure on grass we always give directions to our

men not to drive beneath the oak trees with which the pasture is studded. Moreover, what grass there is found growing under the trees has in it little sweetness or richness, and animals do not care to eat it. No one loves trees better than I, and we have them in our pastures, but we consider that amount of land covered with trees as forest land, park land or what you like, not pasture land. I do not like sheep to lie under trees during the heats of midday, as they pollute the grass with their droppings and afterward myriads of parasites appear, and when the grass springs fresh and green lambs nibbling it take them in and are sickened and destroyed. While I would not, from æsthetic reasons, counsel the destruction of all the trees in the pasture, yet I should expect to get larger returns from the pasture that had at most only here and there a tree scattered over its surface, and most profit of all from the field that had not one tree, but where animals grazed in the open and took refuge from the sun if at all in airy sheds which might be situated on the highest land and whence manure would be taken from time to time and scattered over the field. The waste of manure under trees and in pond holes and streams from pastured cattle is a serious drain on the resources of the land and one that no field can forever safely bear.

Turning to Grass.—Once I ranched in Utah and we had 2,000 cattle running over the desert hills in winter, eating the dry grass. Commonly they kept their flesh fairly well, though after the snow had gone they must make long marches over hard and stony trails to water and back again to grass. We lost few from starvation,

however, until grass came green in spring, then suddenly the cattle grew weak and our troubles began. It was literally true that 10 times as many cattle starved to death after green grass came as before that time, though the weather was much more favorable then. The fact is that the first upthrust of the grass contains little more than colored water; there is need of long days of sun to put any sweetness or strength into it, and this is as true of clovers and all plants grazed by beasts. It is often well to allow cattle or sheep or horses to roam over the pasture during winter; it is well if they are fed on it, since thus the pasture is enriched, but the moment the grasses begin to spring into growth at the advent of warm weather, every animal should be taken off and confined to the barns and yards. It is better for them, because they will then continue to eat their dry hay and grain with good relish. Their gains will be far greater than if they were distracted by the lure of tempting morsels of green grass, about as fattening as pickles to the schoolgirl. It is better for the grass, also, because having been besieged all winter by cold and darkness, it now needs a chance to stretch up into the sunlight and elaborate its sap, strengthen its root system, and in general organize itself for the season's campaign. There may be three times the weight of grass taken from a properly managed pasture than will come from one gnawed down right to the earth from the day it first turns green in the spring. I am convinced that this one almost criminal blunder of too early stocking, more than any one other thing, has tended to make pastures unprofitable. Many evils result from the

practice. Weeds are encouraged, since through animals gnawing the palatable grasses weeds get started on the almost bare land, then the soil has too little shade and the sun dries it out badly. Probably twice as much available moisture is retained in the pasture that is allowed to get a good strong start in the spring, as is found in the pasture grazed down hard from the start. In short, make a soil mulch of the grass itself. You can not cultivate grass land; the one thing probably that you can do to help retain moisture is to allow the grass to mulch the ground. And even here one must use discretion.

Conditions vary according to localities. There are moist regions where it is safe to pasture rather closely—where, in fact, the grass falls and becomes matted together, so that it no doubt loses its sweetness if not grazed fairly close. Most of America, however, has hot suns and dry weather so that the pastures need moisture more than any other thing, and the one way to maintain it is to avoid close grazing until in midsummer or a little later, when it becomes necessary. I have seen bluegrass in north Missouri make a dense mat a foot thick over the ground and cattle fattened well on it. On the other hand Prof. Lyman Carrier of the Virginia station writes as follows:

"I have been making some notes on pasture management in this part of the state and a few things seem to be of importance. One is that heavy pasturing in this section is better than light. This seems to be contrary to the general opinion of writers on the subject. We can ruin our pastures by leaving them ungrazed for a year or two. I do not mean to say that the pasture should be grazed early in the spring before the grass gets a good start or late in the fall

after growth has stopped, but during the summer I do not believe there is much danger from over-grazing, but, on the contrary, heavy grazing will give the best sod. We are working on the matter of weed eradication and have seen various instances where broom sedge and other troublesome weeds have been destroyed by feeding a haystack on the infested area and also by liberal dressings of stable manure."

This indicates that the question requires quite local interpretation. Deeper in the Virginia mountains, in a moister region, perhaps, lives Henry Stuart, a leader among cattle grazers. It has been his experience that there should be "good grass in June and just enough cattle on it so that the grass keeps gaining a little all the rest of the summer." Thus he makes his export steers, and after they have gone he puts younger, thinner cattle on the pasture to graze in the fall.

Rotate Animals in Pasture.—Where possible it is best to feed off the pasture with different classes of animals in rotation. Horses like one class of herbage and cows a different sort, while sheep eat things that both horses and cattle reject. If then the pasture can be grazed alternately by each class of stock, or if they can live peaceably together, the whole field will be well eaten down together and few spots left to grow up untouched. Sheep also will aid greatly by keeping down the weeds. If brush comes in to trespass, goats will aid in destroying it. Naturally, the animals first put in take the cream, the sweetest clovers, the best herbage, and those coming later may not thrive quite so well unless rains cause the swift upspringing of the tidbits again. There is one great advantage in rotating animals on pasture—they do not take parasites from each other, so the sheep

do not by the germs they may drop on the grass endanger horses or cattle, and vice versa.

Managing the Rank-growing Spots.—On good strong soils there will be spots where grasses will stand uneaten, while other places will be gnawed too close. This is a serious waste of pasture land, the richest soil doing no duty while the poorest is overworked. The best remedy may be to mow off the rank spots, setting the knife as close to the ground as it can well run, and making into hay the herbage taken off. It will commonly be greedily eaten in winter. I have even mowed it and left it stand in the field in large cocks and seen it all eaten, nearly, the perverse animals that had steadily refused the grass while it was green crowding around to eat it after it was made into hay, neglecting the green and growing grass to so do. I suppose that animals are lazy enough to like part of their feed cut for them. On soils needing lime, after cutting off the herbage from these rank-growing spots, one can lime them well. Or it may be that they need drainage, though there is no doubt at all that animals will refuse to pasture down places that need neither liming nor drainage, some difference in the flavor of grasses determining their choice.

Weeds in Pastures.—The best way to exclude annual weeds from pastures is to feed the grasses. The one weed that may come no matter how good the grass is is ragweed *(Artemesia)* and this will be eaten by sheep if they have access to it. To help the pasture, run the mower over it if need be. Cockleburs are troublesome in some pastures, but if they are kept mown off for two years they will very nearly disappear. This is true of

most annual weeds and some perennials. One can set the mower so high that it will not especially injure the grass. Ironweeds *(Vernonia noveboracensis)* are troublesome perennials. After 40 years of more or less persistent struggle with them in one of our pastures they are still present, though much reduced. Mowing off just as they come into bloom, and feeding with sheep which eat off their leaves when young and tender, seem the available remedies. Ironweed comes in the best soil and troubles over a very wide area; its roots are very large and strong. Mulleins are biennials and are destroyed by pulling or mowing just as they bloom. Coarse rank weeds such as horseweeds *(Ambrosia trifida)* and jimpson *(Stramonium)* are easily destroyed by mowing; in fact, the mowing machine is a most effective ally of the pastoralist. Some weeds are destroyed by sprinkling repeatedly with strong brine. The nettle is thus affected, as also is poison ivy *(Rhus)* and the horse nettle *(Solanum Carolinense)*. This latter weed is a distressing one, and is now invading all of the central states. It has not one use nor redeeming feature, nor, after it is established all over one's farm, can it ever be eradicated; so it should be fought to a finish at the outset of its invasion. One of the most persistent and troublesome weeds is spearmint. Mowing twice during the season greatly injures it, and will in time perhaps destroy it. Hoarhound should be pulled by hand as soon as it appears. Canada thistles; who can in a sentence dispose of them? In England farmers content themselves with cutting them down once or twice a year to prevent their seeding. They will continue, however,

to spread from roots. Canada thistles may be destroyed, if there are but few, by continually putting salt on them, and as soon as they reappear they should be seasoned again. Cattle will eat them. They may be destroyed also by persistently cutting them off just under the ground with a sharp hoe. A field badly infested may be cleaned by being sown to alfalfa; the frequent cutting of the alfalfa, and its competition for soil moisture, cause the weed's destruction. One must, however, make the soil right for the alfalfa or it will not be able to do the task. Afterward, if the land is desired for pasture, it may be sown to grasses without disturbing the alfalfa, and soon it will be more richly set and more productive than before.

The common or bull thistle is a biennial and easily destroyed by cutting and preventing its seeding. My father thought these thistles worth letting alone because of their soil-enriching powers. Doubtless their large tap roots may open the soil, and the rest it gets where the thistle stands has some effect. Of docks he felt differently, and dug them out religiously. He had a story of a blind man who wished to buy land and was driven into the field with his old horse. "Just tie him to a dock, will you?" he asked the would-be land seller. If the man replied, "Aye, I can do that easily enough," the sale was all off, but if he replied, "There's no docks hereabout but here's a thistle that will hold him," the blind man closed the deal for the land forthwith.

English farmers sow some yarrow in their pastures; sheep graze it somewhat, though in America it seems to be practically uneaten and is a somewhat troublesome

weed. Digging it out or killing it by salting seems the remedy. Plantains and weeds in the meadow are eaten in pastures pretty well. The daisy *(Heliopsis helianthoides)* is a bad weed in eastern meadows and pastures. It thrives in soils deficient in lime and fertility, and will not persist in rich soils well grassed. The remedy therefore is to add to fertility and crowd it out, meantime cutting before it seeds.

Mosses and Ferns.—In northern latitudes on moist land there is often rank growth of ferns and large-growing mosses, which so completely occupy the land that there is no space left for grass. These are most troublesome on rather poor land deficient in lime. The remedy for moss is drainage, lime and enriching. Ferns may be slowly killed by repeated mowings or they may need thorough cultivation following deep plowing.

British people are great students of pastures. They grow large numbers of grasses, clovers and other plants together, believing that by such means they get the most good. They may be right for their own localities, though it would seem that the highest quality in a few plants would be more useful than more mediocrity. With the view to determining the relative value of different species of grasses, and of different species of plants other than grasses upon the permanent pastures of England, the Royal Agricultural Society appointed a commission, which, after investigating the subject for several years, reported that in different pastures the species of cultivated grasses ranged from 11 to 100 per cent, of legumes from zero to 38 per cent and miscellaneous plants, so-called weeds, from zero to 89 per cent.

No correlation whatever was found between the value of the pasture as shown by the beef and mutton produced, and the botanical character of the herbage. Pastures with widely varying proportions of grasses and other plants produced equally good results; while pastures with the same percentages of grasses and other plants gave widely different results, according to Hunt.

In Great Britain it is common to sow such plants as burnet (a plant of the rose family), chicory, (a deep-rooting plant that is supposed to benefit soils by its deep root), yarrow and many others. Of all these we can only render the Scottish verdict, "Not proven." To the writer it would seem that two or three grasses best adapted to a soil, with as many clovers, will commonly give better results than more, and, in fact, the seeding of rare grasses is almost impossible owing to the poor germination of many of the seeds found on the market.

What Farmers Buy in the Middle West.—Men whom I know have sold grass and clover seeds for several years and the following figures, showing what is called for, may prove interesting. They make a specialty of alfalfa seed and advertise it, so it would be misleading to compare their sales of alfalfa seed with the sale of other seeds, but excepting that many men buy clover and timothy seeds of their local seedsmen, the list should be in line with the demand. In percentages they sold of red clover, 100; mammoth clover, 32; alsike clover, 36; crimson clover, 32; white clover, 6.4; sweet clover, 8 (the demand rapidly increasing); timothy, 88; brome grass, 16; all the fescues, 16; Kentucky bluegrass, 10.4; redtop, 6.4; orchard grass, 6.4; Canada bluegrass, 4.8;

English ryegrass, 1.6; tall oatgrass, 1.6; Hungarian millet, .32; German millet, .8; hairy vetch, .8; spring vetch, .24, and alfalfa, 800.

What Might Be Introduced into Pastures.—In Normandy and parts of southwestern England apple trees are grown in pastures, not so much for the purpose of feeding the animals as for making cider. Still, I have often thought that if sweet apples were grown in pastures there would be good profit resulting, and the idea is worth thought in regions where apples grow easily. Persimmons grow spontaneously in all the region south of the 40th parallel, and their fruit is relished by pigs and sheep, so in clearing pastures in the South I have directed that persimmon trees be spared, but thinned somewhat. Mention has been made of the black locust tree, the leaves of which seem to enrich poor soils and make bluegrass come. The best grass on many a hillside in Kentucky and the Virginias is in the groves of locust trees. I am acquainted with no other tree which has so much helpfulness. Most trees are "poison" to atmospheric nitrogen; they are giant clovers. I should, if I lived in a climate as mild as that of Virginia or Kentucky, introduce the furze or gorse plant, and get it growing on my poorest hillsides, as it does so freely on poor hillsides in Europe. Gorse is a leguminous, spiny shrub, with tender, nourishing young stems in the spring and during the growing season. It affords much browsing for cattle and sheep, enriches land somewhat and beautifies a landscape when blooming in spring. In Scotland there is a saying that "when the gorse is out of blossom, then love is out of fashion," but in Scotland

they say that the golden gorse blooms every month of the year! The broom, too, is a legume; is eaten more or less by sheep, is a lovely shrub, and should be started in wild, rocky pasture lands in mild climates, as indeed it is in the Willamette Valley in Oregon and in Bedford county, Va. One can buy seed of either gorse or broom of European seedsmen. Gorse is sown as a hedge plant, on the tops of earthen walls, in Guernsey and Jersey, and its branches bake the bread of the cottager after they have served their purpose of keeping the cold wind from the browsing cows. Gorse needs inoculation, probably, to succeed in America. There are other things that we could bring in to special localities with climates suiting, and in time our pasture flora will no doubt be considerably enriched.

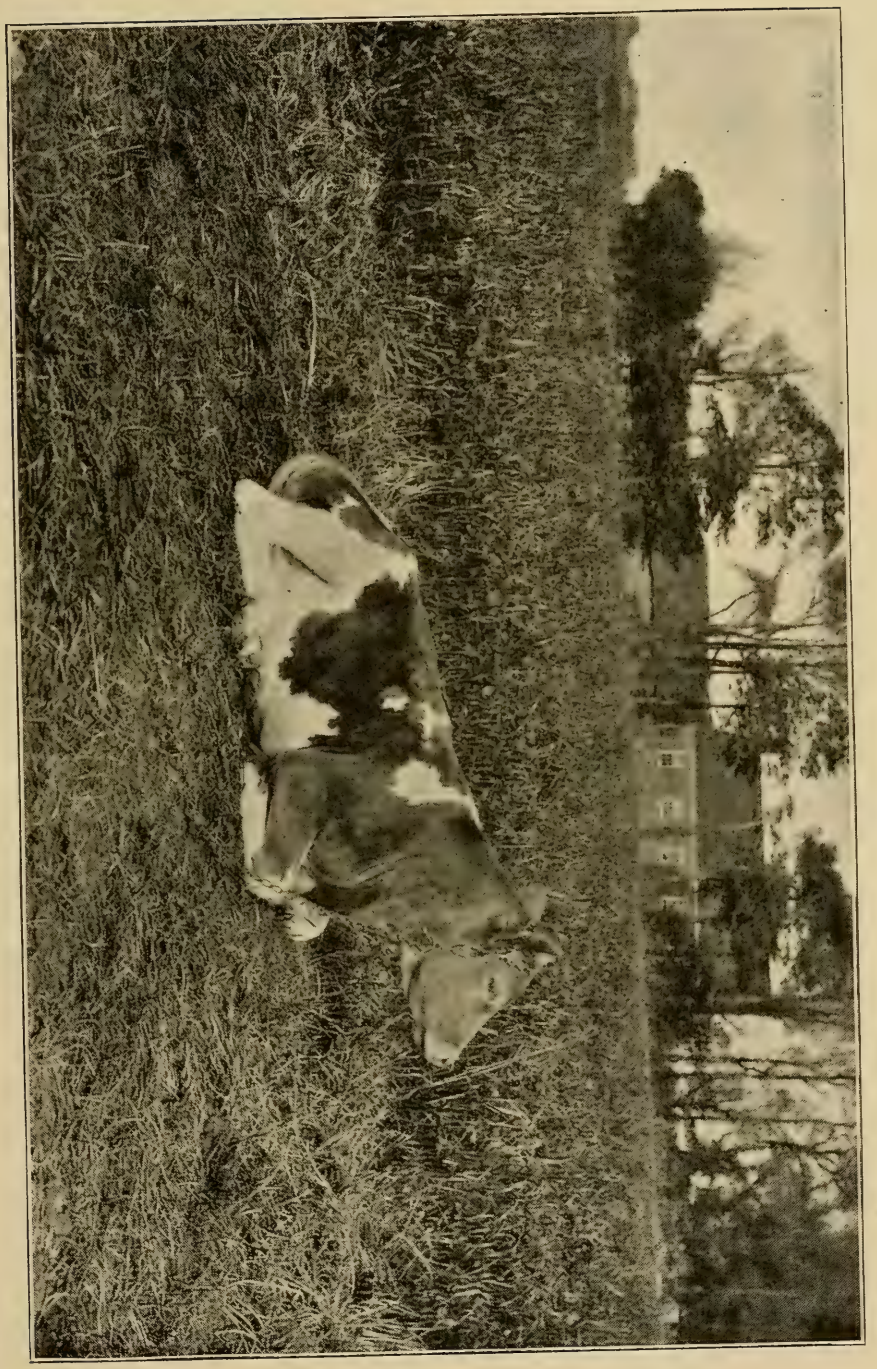
Sir Walter Gilbey's Idea on Overstocking.—Sir Walter Gilbey, a careful student in England of the horse, seems to have found clue to the disappointment that so often follows attempts at horse breeding. There will be seen, for instance, that one or two wonderful horses have come from certain pastures and then men will undertake to produce there many colts, hoping that they also will have great excellence. In this they are frequently disappointed. To quote Sir Walter: "I trust that my practical experience as a breeder of most descriptions of stock may be held to excuse me for offering an opinion on so important a subject as the raising and feeding of blood stock. Whenever large breeding studs have been established, I have found, in every instance, that after a period the animals have failed to maintain their original standard of excellence. I am convinced

that their deterioration has been due to the overgrazing of the land whereon the dams and young stock were pastured—overgrazing, or 'staling,' of the land reacting unfavorably on the horses; and that soundness, bone, muscle and stamina depend very largely on the treatment of the dams and young animals which, above all things, need fresh and untainted grazing."

I should be glad if every horseman would read the whole of Sir Walter's thought-arousing little book. Here are some of the thoughts: In nature horses graze wide and are ever changing their grazing ground. In order to be kept in their full health and vigor they still require to be shifted from pasture to pasture, and their thrift is immensely increased if they are allowed to run where no horses ran the preceding year. Mention is made of customs in Norfolk where one horse and no more is allowed to graze over 6 acres. Keeping mares in restricted pastures, even with good feeding in addition, commonly results in weak foals or disorders of one sort or another. That elusive but very real thing called "quality" is developed on new pastures or on pastures where but few horses run, and the range is very wide. After observing that these pastures produced fine animals men have often stocked them more heavily with greater numbers of horses and have been amazed to see that they did not again reproduce animals of like remarkable parts and qualities. To quote again, "From the time of her conception she (the mare) should be allowed to run in fresh, untainted pastures; if in pastures where horses have not been for the last three years, all the better. After foaling the same policy should be adopted towards

the mare and her foal as regards fresh herbage. The foal from its weaning should be treated in as natural a manner as possible; turned out and fed on pastures where the herbage is succulent, and allowed a free run at his pleasure. Not more than three yearlings should be turned out in any one pasture, and the field should not be of less extent than 15 acres."

I have seen many instances to prove the soundness of this position. On a ranch where I once lived in Utah the mares ranged very wide, having no restrictions. Though not always well fed they were remarkably healthy and prolific, and lacked little of dropping 100 per cent of foals and all of them were strong and healthy at birth. I have seen men make strenuous effort to produce draft colts when they had very small but good pastures; they kept the mares well and got them in foal fairly successfully, but raised very few colts, while neighboring farmers who had wider pastures and fewer horses had "luck" and raised many colts. There seems something in the restricted range and the grazing of mares after one another that lowers vitality in the offspring, even if it does not noticeably lower it in the mares themselves. If one must use small and overstocked pastures for mares one should at least endeavor to lessen the overstocking by keeping the geldings off some of them and putting the mares when possible in meadows or outlying grass. I have seen in the West large bands of draft mares turned in alfalfa meadows with grass pastures adjacent and they foaled well and the colts throve. Wide pastures for pregnant mares seems the safe rule. Pasture of some kind seems most essential. Mares confined



Tethered in Crimson Clover (Island of Guernsey).

to the stable with no access to grass seldom drop strong foals.

Pasturing by Tethering.—In France, the Channel Islands, Denmark and other countries of Europe it is common practice to tether cows and horses (the latter more rarely) in pastures, letting them eat the grass clean as they advance. Twice daily the tethering stakes are taken up and moved forward, maybe no more than a foot and maybe two feet or more, depending on the length of the tethering chain and the quality of the grass. The practice is a good one where labor is cheap enough to give the animals attention and where the climate permits. Water is taken to the cows in some instances; in other places they are led away to water. This system insures even pasturing of all the land and the deposition of the manure where made. I do not think that we are ready to adopt it yet in America except in places where dairy cows are kept, pastures are rich and there is labor enough to give them attention. In Denmark I have seen ewes tethered behind the cows, eating what they had left, while their lambs running free went forward and ate what pleased them. The results were good, as all the animals throve, though I should suppose that the cows would ordinarily leave too little to keep the ewes well.

The Hurdling System.—The visitor to rural England is amazed to see the wonderful flocks of sheep kept often on comparatively little land. I have seen 2,500 Hampshire sheep kept on 1,400 acres of fairly good land in England. Most of these sheep were in hurdles. Briefly, the hurdling system is this: The farmer has panels of movable fence; in England they are commonly made

of small round poles and twigs; here they could easily be made of light wood which should be creosoted. He encloses an acre, more or less, of good forage which may be of pasture grass, vetches, rape or a mixture of forage crop. In this enclosure sheep are penned until they have eaten the land nearly bare. It is common practice to enclose enough so that it is eaten off daily, so that each evening the flock is given fresh pasturage. If there are lambs, two enclosures are made, and through creeps the lambs are allowed to "go forward" into the enclosure farthest into to the field, the ewes remaining behind but being turned the next day where the lambs had been, while the lambs again go forward to fresh grazing. There is no better manner than this of feeding off stuff, if one has time to attend the sheep and move the hurdles. In America there is often some need of shade, also, which can often be best afforded by letting the flock come at 10 o'clock to the cool barn sheds, which should be airy and clean. At 3 they would go again to their hurdles. Temporary shelters from the sun are also used in America; even tents have been in use, but they are troublesome and subject to windstorms. In a system of feeding off crops by hurdling there is little waste, small danger of the animals becoming parasitic, and thus the greatest bloom and health are seen in the flock. It is a system practiced by some well-known ram breeders in the United States, and with the best results. After the land has been eaten over it is common in England to plow it and sow to Swede turnips, crimson clover, winter vetches or some other quick-growing crop for later use.

Sheep on Permanent Pastures.—Sheep in the West have few diseases apart from starvation and predatory animals. In eastern pastures they find enemies far more deadly and insidious, the internal parasites. He who conquers the parasite has nothing else to fear in sheep-farming; the other problems are simple and easy. The history of the stomach worm, the parasite creating the worst ravages in American flocks, is briefly this: It is a small worm about ¾″ long inhabiting the fourth stomach of the sheep or lamb. It causes anæmia or bloodlessness, disordered digestion, scours, constipation and in lambs death and in old sheep emaciation. The worms live from year to year in the bodies of the old ewes; their eggs are deposited on the ground, hatch and the small worms develop and crawl up a little way on the green grass. Lambs eating them become afflicted and a whole train of terrible consequences ensues.

Stomach worms have done more to deprive eastern pastures of sheep than all other causes combined. There are certain things that will decrease their work. Remembering that ewes carry over the germs, one can confine ewes and lambs to the dry lot and barn until the lambs are old enough to wean. If the ewes are bred for early lambing the lambs will be old enough to wean by the time grass is sweet and strong. The lambs may then be taken to fresh pasture with no old sheep mixed with them. If the pasture had in it no sheep at all for 12 months or more all the better. Thus treated lambs will commonly be clean and thrifty. There is little danger of infestation in dry lots, though one should early treat scouring ewes with worm-eradicating medicine. One

and a half ounces or more of coaltar dip diluted with 6 ounces of water and administered to a ewe is said effectually to rid her of stomach worms. Scouring ewes may infect through soiling of the teats. Some shepherds practice separating the ewes and lambs each day, putting them together in the yard at night and the ewes in one field and the lambs in another. This has given clean and thrifty lambs.

Sown Pastures for Sheep.—The most practical thing perhaps is to use only sown pastures for sheep. There seems little danger of infestation when ewes and lambs graze rape or red clover or oats or vetches. The reason for this immunity is probably that the animals do not graze so close to the ground as when on bluegrass or other permanent grasses, so do not so readily take in the worms or germs. Even here there is fear lest the sheep have access to small plots of old grass, maybe along fences or in yards to which they are given access and which though small in extent may infect all the grazing animals. When one is turning to fresh and clean pasture one must strictly avoid letting animals have access to old and infected spots.

Feeding Tobacco to Sheep on Pasture.—Tobacco feeding has come into favor and seems to have much merit. Tobacco will not always eradicate worms in a sheep, but it will often serve to prevent their lodgement. One can use stems or "trash" or any waste tobacco. There is no fear of their eating too much; they should be given all that they will take. I have found that to dip the tobacco in not very strong salt water, taking out at once and putting it in boxes where the sheep can have access to

it and feeding no other salt, is an effectual way of getting them to eat a good deal of tobacco. Some will naturally eat more than others. I have testimony from many men that this treatment has been most helpful. Where tobacco dust is fed, one may sprinkle it lightlty with salt to encourage sheep to eat a good deal of it.

Management Insuring Healthy Flocks.—Two men in America fought stomach worms all through the disastrous years of the 90's, when little was known to help; they found light, they conquered the pests in a measure, and kept on keeping sheep and studying flock management. Finally each made a journey to England and studied the conditions there with a view to solving the problem for America. There they found hurdling the best answer to the question. Independently of each other they reached the same conclusions as to the practical solution of the question in America. Dr. H. B. Arbuckle of West Virginia and the writer were the two men. But they wish to give all due credit to the Department of Zoology of the Bureau of Animal Industry at Washington for at least giving accurate details of the history of the Hæmonchus contortus (formerly called Strongylus contortus), for without the details that we now have no certain plan could have been formulated. The basis of this plan is the fact that lambs are born free from parasitic infection; they are healthy. It is only necessary to keep them healthy by preventing infection. Their mothers carry over in their bodies the germs that will infect them in the form of mature stomach worms, which when ripe pass away in the droppings and thus infest the pasture. When the temperature is below 40° F. the eggs will not

hatch. When it is above that they will hatch out in a few hours or in a week or so, depending upon how warm it is. Freezing or drying soon kills the unhatched eggs. So it is seen that ewes will not pollute a field in winter, their droppings are sure to be soon frozen, at least in the region where sheep are mostly kept. But if the tiny worm hatches from the egg it feeds for a time upon the material of the manure and continues to grow till it is about one-thirtieth of an inch long. Then it creeps up on a blade of grass and waits to be swallowed by some lamb, after that it finishes its growth within the fourth stomach of the lamb, and, incidentally, finishes the lamb as well. The ewe flock should be treated for stomach worms. This is best done in the fall, when they come from pasture. It may be again done in the spring before their lambs come. The use of some of the coaltar dips, in small doses, much diluted, will eventually be recognized as most efficient. This treatment alone has doubled the weight of lambs in some experiments in Kentucky. Next, the flock should at the approach of spring weather be confined to the yard and shed. There are two reasons for this: it is better for the grass, and thus in the long run better for the flock, and there is no contamination of land over which the lambs will later feed. If it were possible wholly to eradicate the worms from the ewes by treatment this care would not be needed, but unfortunately it seems almost impossible with our present knowledge to kill all of the worms by any medication. While confined to the yard the lambs will probably be born. It is essential that the flock be well fed at this time, so that the ewes will be full of milk. If desired they may be

provided a run to a rye-field, or to some grass pasture that will not be afterwards used that summer, to help stimulate the milk flow. By May 15 probably the grass will be so forward that the flock may be turned out for good. Now begins the new management.

Instead of turning the flock to a large pasture to roam over it at will turn them on a very small part of it. How best to manage this will depend on circumstances. I think that in our land of small supply of labor and much hurry and turmoil during the summer season it is safest to divide the pastures by permanent wire fences. These are not costly, and need not be very high. We will, then, turn the whole flock together into the first division; none shall be scattered about. Of course there may be two flocks, one with lambs and a dry flock, but the dry flock had better be put apart somewhere or else put with the ewes. It will not do to let anything interfere with the regular rotation of these pastures. Now once in this pasture the flock will be allowed to eat it down close to the ground. That will not hurt the grass, for all will go in a short time and the grass may spring up again. This is how pastures are often managed in England by hurdles.

Dr. Ransom says that sheep may probably be safely left on May pasture for two weeks. We will shorten this time to 10 days, to make sure. That is, the germs falling to the earth could not before 10 days find their way back into any sheep or lamb, and we are going to move the flock on before they are able to get in. Now in the division between this pasture and the next we will place creeps so fixed that the lambs can readily pass

through to the next enclosure. This they will early learn to do, and so they will be eating the fresher parts of the herbage in advance of the ewes. In 10 days then the whole flock will go forward one pasture, the lambs yet having access to the fresher feeding on ahead. Doctor Ransom says we shall need for this sure treatment the following divisions: For May, 2 pastures; for June, 4 pastures; for July, 4 pastures; for August, 4 pastures; for September, 3 pastures; for October, 2 pastures. That makes 19 enclosures in all and insures that the flock shall be kept in absolute freedom from infections throughout the year. However, one will not absolutely need so many enclosures as that. By June many of the lambs will be ripe, by July many of the others, and even when the lambs are born late, when managed in this way they should all be ripe as peaches by the middle of August. After the lambs are gone the ewes can be managed a little less carefully, especially if they are in strong condition, though there is a comfort in knowing that every stomach worm germ that falls to the earth must die from lack of a host.

To make this thing doubly successful put flat-bottomed troughs in the pastures ahead, where the lambs run, and put feed in them; any sort of grain, corn, oats, barley, bran, coarse-ground or broken cake or oilmeal. Thus the lambs will grow like weeds and pay many times over for their grain. Thus more sheep may be carried on the same ground than would be possible under ordinary treatment. There is scarcely any limit to the number of sheep that can be safely kept on an eastern farm under this system of management. The limit is, of course, the size of the farm and the amount of grass.

Even this can be greatly helped by soiling. Racks may with great profit be placed in the fields and the ewes fed with green crops, fresh mown oats, peas, clover or alfalfa. Thus twice as many ewes may be kept as the grass alone will support. I suggest that about 400 ewes would keep one man nicely busy in caring for them and their lambs, hauling water to them, soiling somewhat, and feeding the lambs. I would not hesitate to undertake the management of 400 ewes on one farm in any part of the cornbelt, the regions most infested with stomach worms. There is no business more sure of profit than this. Lambs sell remarkably well and the prospect is that as the western ranges are diminished they will sell better, for the ravages of the stomach worm deter eastern farmers from going into the business. The two serious obstacles to be overcome are: first, the question of water and next, the question of shade. Water is readily hauled in mounted tanks as it is usually in England. Shade is not absolutely essential. I have seen very fat sheep in the San Joaquin Valley of California confined to the alfalfa meadows and with no shade whatever. Probably a system of canvas sheds, long and narrow, would not be very expensive nor too troublesome for one man to move and set up unaided. Any sort of grass will serve. Kentucky bluegrass is to be preferred, perhaps brome grass is better, clovers may be utilized and oats sown to be grazed off, with peas.

I do not hesitate to say that I look forward to seeing many sheep farms established in the cornbelt, each carrying from 200 to 500 ewes and managed nearly under this system. I feel confident that no other branch of hus-

bandry holds forth better prospects. It should be borne in mind that the earlier the lambs are born the sooner they will be gone to market, and thus the fewer pastures will be needed. Also the market is usually best in June and July, after a flood of fed lambs has passed and before the new crop from the ranges has started to come. Besides the stomach worm there is the worm that makes the nodular disease of the intestines. Any observant man who has dissected a mature sheep has often noticed on the small intestines little nodules or "knots." These are really small tumors, filled with a greenish, cheesy substance. They do not do much harm when they are few in number but the trouble is a cumulative one and the numbers of the nodules increase until after a time digestion and absorption are much interfered with. Sometimes parts of the intestines become calcified; that is, so impregnated with lime salts that they are almost like stone. Death ensues in a longer or shorter time from the nodular disease. It does not work quickly as does the disease caused by the stomach worm. The worm causing these tumors is called œsophagostoma columbianum.

Nodular disease is difficult to cure, if indeed it is possible to cure it at all after it is established. Prevention is about all that one can do. Dr. W. H. Dalrymple of the Louisiana station has shown, however, that it is readily communicable from affected ewes to their lambs through the medium of the pasture. He has also demonstrated that where diseased ewes are kept confined to the barn and their lambs allowed to run on clean pasture not contaminated by the presence of any old sheep, the

lambs remain healthy and thus a new healthy stock can be had even from a diseased flock. None of these diseases originates spontaneously. There are no other known hosts of these diseases than sheep, goats and perhaps deer, so it is merely a question of starting with the lambs, born free of all parasites, and keeping them in health by putting them on fresh and uninfected pasture. This insures freedom from these devitalizing pests.

Feeding Sheep and Lambs on Pasture.—There is often good profit in feeding western lambs or natives on grass in the spring, summer or fall. At this art some men succeed admirably; others fail lamentably. The keynote of success is to put the troughs in a small yard which may be moved from time to time as the land gets foul. When grain is put in the troughs the sheep must be excluded; afterward all must be brought in. It will not do to depend on their intelligence or memory; pigs can be called to feed and will all come, but this is not so as to sheep or lambs, as a rule. The shepherd must see that every one comes to its feed and that none goes away until the feed is all consumed. Sheep are imitative animals and if one leaves its feed others may follow, letting those that remain have a chance to overeat.

Feeding Sucking Lambs on Pasture.—I have found great profit from feeding young lambs corn on the grass in April, May and June, as one would feed pigs. I would fence a place so that the ewes could not get in or else give the lambs access through creeps to a pasture from which the ewes were excluded and feed them ear corn, simply throwing it down on clean grass and letting them shell it as pigs shell corn. This mingling of succulent

green grass, mothers' milk and good sound corn produces very rapid gains.

Alfalfa Pasture for Sheep.—For many years it was common practice with us to turn ewes and lambs on alfalfa pasture. Great profit resulted from this practice with some little loss. Commonly about 2 per cent to 4 per cent of the animals turned on alfalfa would die during the season, though there were years with less than 1 per cent of loss. We learned the following points: The alfalfa should always have grasses mixed through it. Timothy, brome grass, bluegrass and even oats or wheat drilled in will serve. When thus mixed it is not nearly so apt to cause bloat as when fed pure. The animals should be kept off until the alfalfa has reached a good growth, almost to the blooming stage. They should be filled with other feed before being turned on, and the best time for turning on is at about 10 o'clock in the morning. After they are once filled with alfalfa they must not be taken off, not even for a half day, nor at night, nor when it rains. Their safety depends on their never again getting very hungry for alfalfa, but on their having it always before them and mixed with grasses that they may eat alternately. The meadow should never be fully stocked, but the mower should run over it twice during the season and the surplus alfalfa made into hay. It may be wise not to mow it all off at one time. The practical disadvantage that we found was that the ewes thus treated would quite often become barren, probably from over-fatness, but the lambs throve wonderfully and remained quite free from internal parasites.

Feeding Colts on Pasture.—In Kentucky, in the best of bluegrass pastures, men growing Thoroughbred colts commonly feed them oats while suckling their dams. This is accomplished by putting railed enclosures about large troughs; the rails are low enough to exclude the mares and high enough to allow the foals to go to their feed. Thus pushed the colts grow splendidly and reach probably the maximum development of which they are capable. In France I have observed that very often draft colts are given the best of pastures and liberal feeding of oats or oats and bran besides. This is good for the colts and good for the pastures as well.

Pasturing Cattle.—It is wise to keep cattle off grass until it has become sweet and good. This is best for the pasture and best for the cattle. When at last they go to grass much can be done to aid them in making good gains. One of the easiest and most useful of practices is to place large portable racks in the pasture and place in them green forage, alfalfa, clover, or whatever may be most convenient. The cattle will consume a great deal of this without neglecting their grazing. Cattle are too indolent to fill by grazing as full as they should be, this especially in warm climates. By means of this half-soiling system the pasture is rapidly enriched and made to support many more animals than it otherwise would. Cattle will also eat a great deal of dry hay or even bright wheatstraw or oatstraw when on clover pasture, and stacks may be thus devoured with much profit right in the pastures. There is great profit in feeding green corn, stalks, blades and ears, to cattle in the fall. Throw it on grass or feed it in racks. If fed

judiciously on good pasture the gains are probably more rapid than under any other system. When cold weather comes on if the cattle have been well chosen they are ready to go to market. There is profit to animals and to grass in feeding linseed or cottonseed meal or cake on grass. The manure from meal or cake fed animals is richer than when they are fed corn and the grass responds well. It is more profitable commonly to feed corn with the meals.

Giving Salt on Pasture.—Ordinarily it is unwise to limit animals in their consumption of salt. After they have become accustomed to salt by having been "salted" for several days in succession one may as well fill a strong box in some place where rain will not leach it away with coarse cheap salt, one sort being about as good as another. When barrel salt is cheapest one may as well roll a barrel into one's shed and cutting a liberal good-sized hole in its side allow the animals to go to it at will. If there is danger of bloating from too much succulent alfalfa or red clover in pasture, slaked lime added to the salt is said to lessen the trouble. Pure bonemeal (it is made especially for feeding animals) should be mixed with salt wherever there is lime-deficiency in the soil. Put in several pounds of bonemeal to one pound of salt.

Making Export Steers on Grass.—There are parts of the Virginias and some other states devoted largely to making steers for English markets to which they are sent alive. It requires for making export steers good grass, good water and suitable climate. It is notable that mountain pastures though somewhat less luxuriant

make more fat than do lush pastures in the cornbelt. Once the cattle making export steers were all raised from Short-horn cows kept in the neighborhood or in nearby counties. Now they are many of them brought from western ranches, especially from the Panhandle region in Texas. The cattle go to grass when yearlings and are fed during their first winter on cornstalks with a few small ears of corn. Some graziers feed considerable corn as grass starts green in spring, though it is not a common practice since not much corn is grown in that region. During the season they are given as good pasturage as possible, care being taken not to crowd or overstock them. They are fat in September, October and November and are sent direct to the seaports and thence to England. The cattle are not when sold as fat as cornfed cattle, but are such as command good prices on the markets of Great Britain. After the export steers have gone to market there is often left much grass that is taken by youngsters following them. There is often very good profit in making export steers. Sometimes more than $10 per acre is received for the grass that they have eaten. Only the bluegrasses have been found suitable for making export steers.

LETTERS FROM EXPERIMENT STATIONS.

Before writing this book I addressed letters to the directors of all experiment stations in America, and to those of several foreign lands, asking for information as to what grasses, clovers and other plants were in successful use in their respective states, and asking them to mention the few that seemed in highest regard. The

following replies seem to have so much interest and merit that they well deserve space herein, and I only regret that it has been found necessary in some instances to abbreviate them.

ALABAMA.—Prof. J. F. Duggar, Director of the Alabama Experiment Station of Auburn:

Bermuda Grass.—This is more generally used than any other grass as summer pasturage throughout the cottonbelt. On the whole it is the most valauble pasturage plant of the South. It can be propagated with greatest certainty by the use of rootstocks dropped in checks 2 x 3 feet and at any time from February to June. It can also be propagated by seed, but the germination of the seed is sometimes poor and there is also danger of the stand being poor by reason of rain and baking sun soon after the date of planting. There may well be combined with Bermuda, lespedeza for summer pasturage, and bur clover for winter pasturage.

Carpet Grass.—Carpet grass is probably next to Bermuda in value as a summer pasturage grass for the region to which it is adapted, namely, the southern half of the cottonbelt. It is most useful on low or damp sandy areas and is especially resistent to an acid or water-logged condition of the soil. It is of slight value on the dry hills. It is superior to Bermuda on the lowlands, to which it is adapted, its superiority consisting in remaining green later in the fall or winter and the greater ease with which, when desired, it can be eradicated. Propagation is most certain by means of portions of the old plants. This plant seeds poorly but is sometimes spread by cutting the seed stems for hay and spreading this over the land to be seeded.

Orchard Grass.—This is of limited suitability and is only available for soils naturally fertile and well-drained or else soils that have been improved by rotation of crops and good farming. It is of more value in the Northern than in the Southern half of the cottonbelt, but even in that region it is not of universal adaptability. Its chief value of course is for pasturage, for which purpose it may well be combined with lespedeza or with other clovers and grasses.

Red Top Grass.—This is suited to the moist lowlands throughout the greater part of the cottonbelt when the purpose is pas-

turage. The best time for sowing is the latter part of September or early part of October. It is not unfavorably affected by acidity of the soil.

Cowpeas.—The cowpea must be ranked as the legume of first importance in the South. Its chief value is as a hay plant and a soil-improving crop. It is also valuable for the production of seed and for pasturage. The pasturage season is very short and as a rule the crop is used for pasturage only incidentally, for example, when live stock is turned into a cornfield where cowpeas have grown as a catch-crop between the corn rows.

Lespedeza.—This is adapted to almost every grade of soil and to the entire range of climate throughout the cottonbelt. It is useful almost exclusively for pasturage, although on very rich land in seasons of abundant rainfall it grows tall enough to be mowed, when it makes a grade of hay equal to alfalfa. This is an annual, which, however, reseeds freely, even when closely grazed. When first introduced into a field the seed should be sown on prepared land in February or March, either among the growing oats or alone, using about one bushel per acre of the seed still in the hull. Lespedeza should form a part of practically all pasture mixtures for the South.

Bur Clover.—This is a winter-growing annual legume which reseeds itself, provided it be lightly grazed, or not grazed at all, during the period of seed formation in April and May. The seed of the southern variety is obtainable only in the bur; that is, uncleaned. In this condition it requires no inoculation on any soil, but requires very early sowing, preferably in August, so as to give time for the rotting of the burs. Seed of the California variety may be obtained either in the bur or in the threshed condition, both kinds of California clover seed apparently requiring inoculation on most southern soils. Here again the burs need to be sown early, but the threshed seed may be sown a month later, or in September. Inoculating soil for bur clover is obtained from an old field of bur clover or of alfalfa.

Hairy Vetch.—This annual winter-growing legume is useful either for hay or pasturage, and also for soil-improvement. It is best grown in combination with either oats or wheat, the mixture being cut for hay. The seed may be sown throughout September and October in most parts of the cottonbelt and the hay cut in May. Sow about one-half bushel of vetch seed with the usual

amount of oats or wheat. On most soils in the South vetch needs to be inoculated. For this purpose one may use soil from a spot in the garden where English peas have grown or from a field of any kind of vetch.

Crimson Clover.—Crimson clover is a winter-growing annual, the seed of which at the rate of 15 to 20 pounds per acre should be sown in September and thoroughly inoculated with soil from a field where either crimson, red, white or Carolina clover has grown and produced abundant tubercles the year before. The seed may be sown broadcast among the growing cotton plants and lightly covered, or, when hay-making is the end in view, the seed may be sown on well-prepared land. This plant should be cut early for hay to avoid the danger sometimes reported from the use of over-ripe hay. This danger consists in the formation of balls in the stomach of horses from the matted hair that develops around the ripening seed. The pasture season of crimson clover is comparatively short. Its greatest value is for soil-improvement.

Soybeans.—This plant is rapidly growing into importance in the South, but has not yet played a prominent part in southern agriculture. Probably the best use is as a crop to be hogged off while the pods are forming and after seed formation is completed. It also makes a nutritious, though rather coarse hay. The plant is of about as great value as the cowpea for soil-improvement, though apparently requiring somewhat better land. It is adapted to a wide range of soils and of climate. The foregoing are arranged in order of importance as I conceive their rank.

Arkansas.—Prof. Martin Nelson, Agronomist of the Arkansas Experiment Station, Fayetteville, Ark.: In naming the grasses that are most suited to Arkansas, I may say, first, as our best yielder for hay purposes and for pasture as well, I will name Johnson grass. I am aware that people of the South are afraid of this grass, but not all, fortunately, are timid. Johnson grass belongs to the Sorghum family. It spreads and perpetuates itself not only by seed but by a jointed rootstalk. This grass puts forth a vigorous growth, stands drouth well and can be cut for hay several times during the season. The yield is heavy. The same characteristics that make it suitable for meadow make it suitable for pasture also. The other grass especially adapted to this state is Ber-

muda grass. It grows thickly and makes a very excellent turf, tends to bind loose soil with a close turf as well as the heavier soils. It is the favorite grass for lawns and parks. It also perpetuates itself by seeding and by the underground system of rootstalk. Its character of growth above the ground is that of many fine stems and it does not as a rule grow very high, seldom reaching more than 18″ or 20″ even on the best of land. It does not start growing early nor grow very late because it is a hot-weather grass. To sow for pasture or meadow purposes, but particularly for pasture, it is necessary to seed other grasses or clovers with it in combination. We have no other grass that will stand as much drouth as the Bermuda. It is dreaded by many of our farmers. Foundation for this fear is largely imaginary. We must admit, however, that it cannot be eradicated by wishing it to be gone.

Other grasses that are pretty well adapted to this state I will name in this order: Orchard grass, tall meadow oatgrass, meadow fescue and redtop and timothy. Clovers have not been given much of a trial in this state. The clover, however, that has demonstrated that it is a good one here is Japanese clover, which comes on of its own accord, both on lowland and upland. Being a small clover it is to be recommended for pasture rather than for meadow, but in the bottom lands it makes very excellent hay in combination with other natural grasses. Another clover, commonly termed yellow clover (*Medicago lupulina*), is also coming in of its own accord and demonstrating that it is adapted to our conditions. White clover is also spreading of its own accord over the entire state. I look on these three clovers as the most promising and would recommend that white clover and Japanese clover be sown in combination with Bermuda grass for permanent pasture and with Johnson grass also. The white clover will produce earlier pasture and late pasture while the Japanese and Bermuda will hold out during the hot weather season. Crimson and burr clovers thrive under ideal conditions and seem to be well adapted to our climatic conditions, though they are both annuals, and for that reason do not persist as we should like to have them do, nor are they first-class hay plants. Alsike and red clover grow with fair success, but as yet we are in the experimental stage with most of the clovers, and find that while they give first-class results in one locality they may fail elsewhere. While alsike or red clover will thrive on the poorest soil, alsike is especially adapted to fairly fertile low-lying

soil that is not too wet. Red clover thrives best on the richer soil, although occasionally is found doing excellently on wetter soil.

DELAWARE.—Part of Bulletin 81: The object of an investigation was to determine what combinations and quantities of commercial fertilizers could be most profitably applied to meadow lands. The experiment was planned by Director Harry Hayward. In the spring of 1907 a field which had been in wheat during 1906 and sown to grass, was divided into 18 one-acre plats. The stand of timothy was not heavy, but uniform, since it had been sown with a wheat drill. The fertilizers were applied with a distributor from April 26 to May 2. The season was favorable, and the grass made a good growth. Harvesting began July 5. Each plat was cut and weighed separately. The following table shows the treatments, the increase due to treatment, cost of fertilizers, and the profit or loss from each plat. Plats 4 and 12 remained as checks—nothing was applied. It will be noted from the table that Plats 1, 2 and 3 received the same treatment, except in the amount of sodium nitrate applied. That is, Plat 2 received twice the quantity of Plat 1, and Plat 3 twice the quantity of Plat 2. The applications of sodium nitrate were thus in the ratio of 1, 2 and 4, while the gain from the treatments is in the ratio of about 1, 2 and 3. The heavier applications—320 pounds of nitrate—did not produce a proportional increase. From these comparisons we are led to the belief that a considerable quantity of nitrogen may be applied with profit. On Plats 2 and 3 the net profit due to treatment was $8.52 and $12.63 respectively, or more than 100 per cent. On Plats 5, 6, 7 and 8 the treatments are the same in kind and quantity, except that the quantity of acid phosphate is double on each successive plat. In other words, acid phosphate was applied in the ratio of 1, 2, 4 and 8. The yields of these plats do not show a corresponding ratio. The fact is, Plat 5, which had 80 pounds of acid phosphate, produced more hay than Plat 7, which had 320 pounds, or even Plat 8, which carried 640 pounds. From this it appears that the quantity of acid phosphate applied had but little effect on the yield. A profit was made on each of the plats except number 8, where the treatment cost $1.68 more than the increased yield was worth. Similarly, the quantity of potash seems to have had but little effect towards increasing the yield. Comparing Plats 10 and 11 as to treatment, the only difference is in the quantity of potash applied, which is four times as much on one plat as the other. Yet the

yields of the two plats show the opposite relation, the one with the lighter treatment producing the heavier yield. A comparison of the yields on Plats 3 and 9 shows that the lack of potash in the treatment has not seriously affected the yield. Plat 3 with 80 pounds of potash gave an increase of 4,890 pounds, while Plat 9 without potash gave 4,170 pounds. Plat 9, however, received but 240 pounds nitrate, which probably accounts for its somewhat lower yield. While no test was made with sodium nitrate alone, or either acid phosphate or potash singly, yet from the foregoing it seems quite likely that nitrogen is the only element which can be applied in quantity with profit on this particular soil. Details are given in the table on the opposite page.

FLORIDA.—Prof. John M. Scott, Assistant Director of the Florida Experiment Station, Gainesville: In Florida we may if we wish have an abundance of forage crops. Many different legumes and grasses can be grown for hay, for pasture, or for soiling. However, out of the numerous varieties, only a certain number are of especial value for pasturing live stock.

GRASSES.

Wiregrass.—In the pine forests, the native wiregrass grows to the exclusion of other kinds. After the pine trees have been removed by the lumbermen it is only a question of a few years until most of the wiregrass disappears, to be replaced by more nutritious grasses, such as the paspalums.

Para-grass.—This may be called a dual-purpose grass, as it either furnishes good pasture for nine to 10 months in the year or it may be pastured only in the winter from February to May. If the para-grass sod be plowed during the latter part of May, a better hay crop will be secured. If used solely for pasturage it will perhaps be found advisable to plow only in December or January. The plowing of the sod gives the grass new life and vigor for the coming year's growth, and also protects it from frosts. In some respects para-grass resembles Bermuda grass, especially in its habit of growth. When growth begins in the spring, runners 10′ to 30′ in length are sent out in all directions, rooting from the nodes. When the ground is fairly covered with runners, upright shoots are sent up from each node, from 12″ to 3′ or 4′ in height. The yield of hay per acre is from 1 to 4 tons.

TOP-DRESSING MEADOW LAND. (Note: Financial returns based on the value of hay at $10 per ton.)

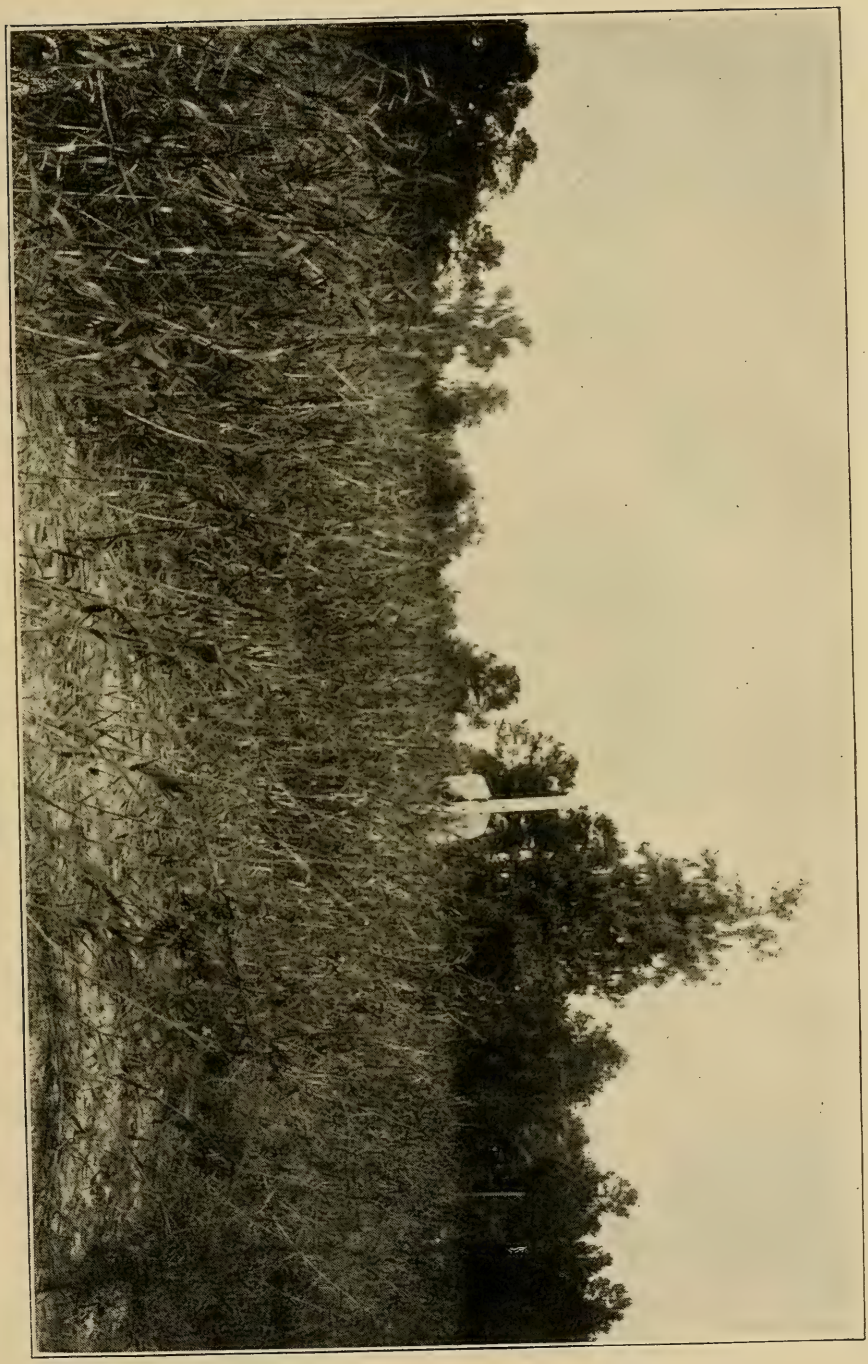
Plat No.	Treatment.								Yield and Profit.				
	Nitrate soda.	Acid phosphate.	Muriate of potash.	Slag.	Ground bone.	Fish.	Tankage.	Lime.	Cost of treatment.	Yield, pounds	Gain due to treatment, pounds.	Value of increase.	Profit or loss.
1	80	320	80	.....	.....	.....	.....	.....	$5.31	3,250	1,520	$7.60	$2.29
2	160	320	80	.....	.....	.....	.....	.....	7.48	4,930	3,200	16.00	8.52
3	320	320	80	.....	.....	.....	.....	.....	11.82	6,620	4,890	24.45	12.63
4	.....	.....	.....	.....	.....	.....	.....	.....	.....	1,730	.....	.....	.....
5	160	80	80	.....	.....	.....	.....	.....	6.32	4,120	2,390	11.95	5.63
6	160	160	80	.....	.....	.....	.....	.....	6.71	3,310	1,780	8.90	2.19
7	160	320	80	.....	.....	.....	.....	.....	7.48	3,920	2,190	10.45	2.97
8	160	640	80	.....	.....	.....	.....	.....	9.06	3,210	1,480	7.40	—1.68
9	240	320	.....	.....	.....	.....	.....	.....	8.05	6,330	4,170	20.35	12.30
10	160	320	80	.....	.....	.....	.....	.....	7.48	6,240	4,080	20.40	12.92
11	160	320	320	.....	.....	.....	.....	.....	12.28	4,980	2,820	14.10	1.82
12	.....	.....	.....	.....	.....	.....	.....	.....	.....	2,160	.....	.....	.....
13	160	.....	80	224	.....	.....	.....	.....	7.73	3,560	1,400	7.00	—.73
14	160	.....	80	.....	224	.....	.....	.....	8.52	4,190	2,030	10.15	1.63
15	.....	.....	80	.....	224	.....	480	.....	10.43	2,960	800	4.00	—6.43
16	.....	.....	80	.....	224	480	.....	.....	13.21	3,560	1,400	7.00	—6.21
17	.....	.....	.....	.....	.....	.....	.....	1,000	2.75	2,050	—110	—.55	—3.30
18	160	100	80	75	75	.....	.....	.....	7.88	3,130	970	4.85	—3.03

Japanese sugar-cane.—This is of course really a large grass, and for heavy yield of green forage containing large amounts of carbohydrates there is perhaps no crop that surpasses it. A yield of 25 to 30 tons per acre is not unusual. This is perhaps three times the yield that one is able to secure from either corn or sorghum. Japanese sugar-cane is a perennial. It does not produce its maximum yield until about the third or fourth year after planting. One planting, with proper attention, will give satisfactory yields for 20 years or more. This in itself gives a considerable advantage over annual forage crops. Japanese sugar-cane may be used as pasture, as soiling crop, for silage or as dry forage (hay). It will give the best result as pasture from about Nov. 15 to Feb. 15. However, it will not stand pasturing in the spring after the young growth has started. For soiling it will give better results if not cut until the crop is fairly well matured. However, it can be fed at any time between July and January. The largest quantity of silage or dry forage will be obtained by harvesting during November or early in December. These dates refer to north-central Florida. When used as a dry forage the best results will be obtained if the forage be run through a feed-cutter just before feeding. Prepared and fed in this way there will be a minimum of refuse and waste. When properly handled, hay made from Japanese sugar-cane may be kept for six months, and still be relished by horses, cattle and hogs.

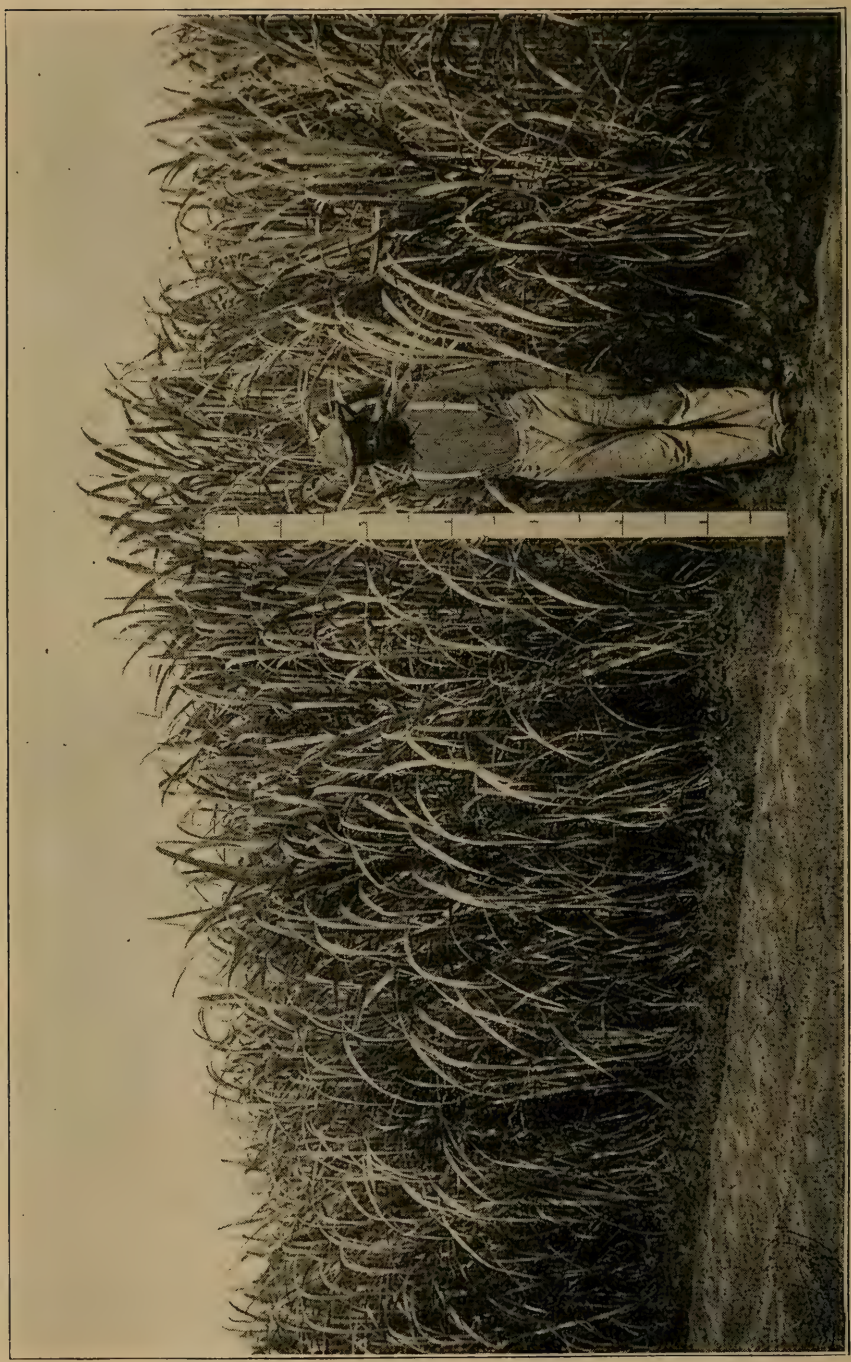
Bermuda Grass.—This is a good summer pasture, is relished by all kinds of stock and is nutritious. From its method of growth Bermuda grass does not make a desirable hay crop except on good rich soil or where it is heavily fertilized. Bermuda will be found to be a satisfactory pasture grass on all classes of soil. However, the sod should receive a liberal amount of fertilizer. Two or three light applications of fertilizer during the year will produce better results than one heavy application. It will be found advisable to go over Bermuda grass with either a disk or spike-tooth harrow each time the fertilizer is applied. This harrowing seems to put new life into the grass, and results in an increased growth of nutritious blades.

LEGUMES.

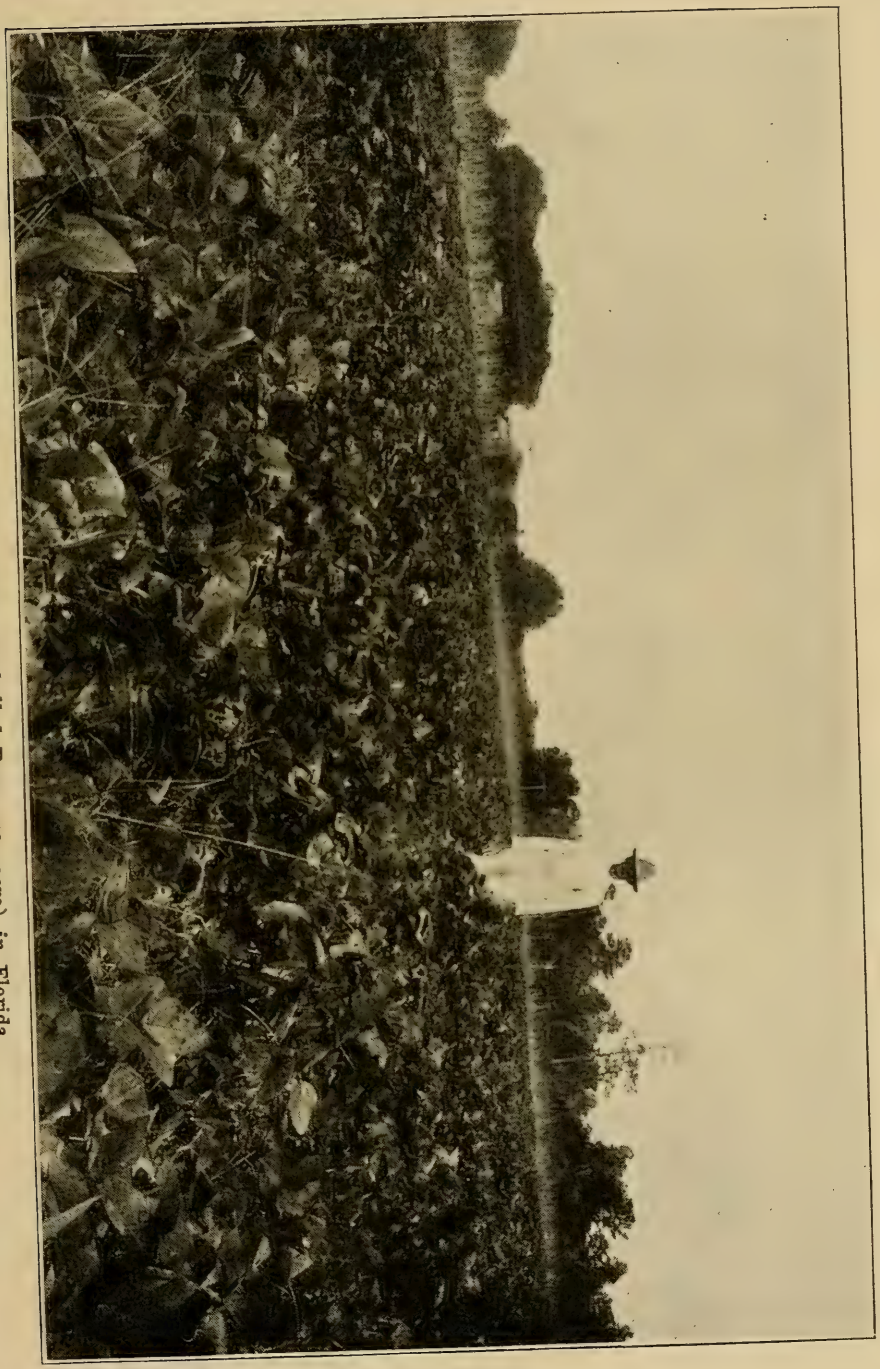
Velvet beans.—Perhaps the velvet bean is the best legume for Florida. It affords without doubt the best winter pasture that can



A Para Grass Plot in Florida.



Japanese Cane (25 tons per acre) in Florida.



Velvet Beans (22 bushels of shelled Beans per acre) in Florida.

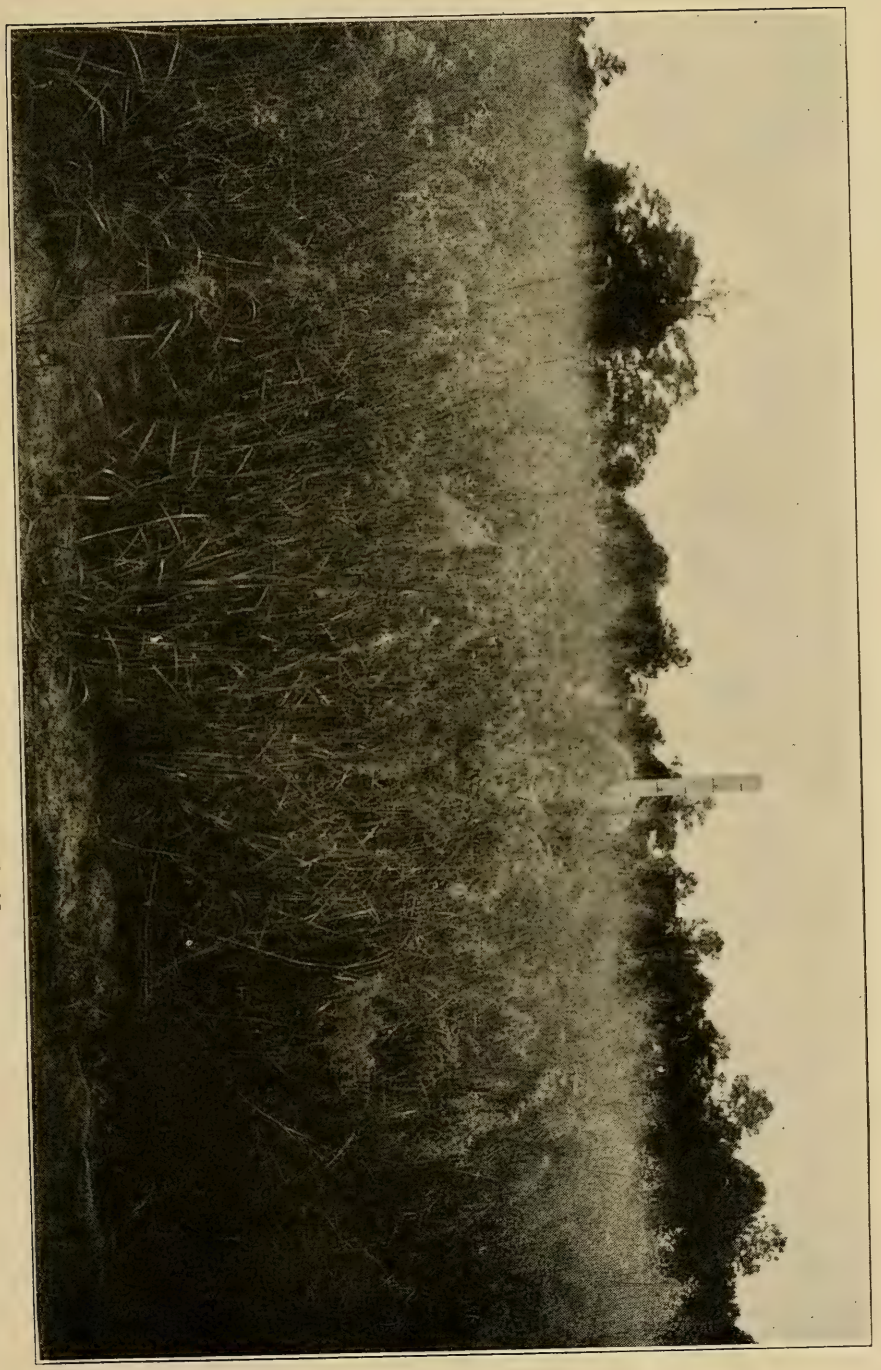
be grown here. Though the velvet bean does not furnish a green pasture at any season of the year, yet it supplies good foraging from December or January until grass comes in the spring. It is usually estimated that one acre to one acre and a half of velvet beans will be enough to fatten one animal. The cost of growing this crop will be from $5 to $7 per acre. The yield per acre varies according to conditions, but 1 ton to 1½ tons of beans is not too much to expect.

Bur clover.—This furnishes good grazing during the winter months. If one may chance to have a good Bermuda pasture for summer grazing it will be found advisable to sow bur clover on the Bermuda sod (say during October), and disk in the seed. By the middle of December this will have made a good growth and will give good pasturage until April. If not pastured too close, bur clover will reseed itself from year to year, and in this way will make a permanent pasture.

SOME HAY CROPS OF FLORIDA.

Crabgrass.—This is perhaps the most common hay grass in Florida. It is an annual found abundantly in most cultivated fields. By some it is considered a noxious weed; but if it were not for crabgrass, there would be but little home-grown hay put on the market. Crabgrass requires next to no attention. If the growing crop be given proper attention in the way of cultivation but little difficulty will be experienced in keeping crabgrass under control. After early crops (such as oats, melons, early corn, cabbage and cucumbers) are harvested it comes up voluntarily, and, as a rule, enough fertilizer will have been left by the previous crop to give the crabgrass a good start and produce a good crop of hay. The yield of hay will be from ½ ton to 2 tons per acre, depending on conditions.

Beggarweed.—Beggarweed, sometimes called Florida clover, is a valuable hay crop; but it is not grown so extensively as it should be. It is seldom seen in the fields during the time that the crops are being cultivated; but like crabgrass it springs up quickly when cultivation ceases. To make the best quality of hay, beggarweed should be cut before the stems become hard and woody. After such crops as oats, melons, cabbage and cucumbers two good crops



Natal Grass (2½ tons per acre) in Florida.

of beggarweed hay can be secured. If the first crop be cut as early as the first week in August there will be time enough for a second cutting.

Natal grass (*Tricholaena rosea*).—This is an annual grass, a native of South Africa, and is now grown to some extent in a number of other tropical and sub-tropical countries. Its appearance before flowering somewhat resembles timothy. When in bloom, however, it is very unlike timothy, and has a purple flower. It has a straight upright stem with many side leaves. It grows from 2′ to 5′ high. When natal grass first germinates and comes up it is almost impossible to distinguish it from crabgrass; but after it has reached a height of 4″ or 5″ it is readily distinguished. It is easy to eradicate natal grass by cultivation. For this reason it is seldom seen as a weed in tilled fields, while the growing crop is being cultivated. But when cultivation ceases natal grass seed may come up and make a good growth, after such crops as Irish potatoes, melons, oats and other early crops have been harvested. In feeding value natal grass hay is somewhat richer than timothy hay. The analysis, as given in the Florida state chemist's report for 1907 is as follows:

	Per cent.
Moisture	9.75
Fiber	36.75
Ash	5.02
Protein	7.45
Nitrogen-free extract	39.23
Ether extract	1.80

The yield of hay from this crop is satisfactory, being from ½ to 4 tons per acre for the season. Two good hay crops can generally be obtained during the year, and under very favorable conditions 3 may be had.

Georgia.—Director Martin V. Calvin of the Georgia Experiment Station, Experiment, Ga.: I regret I can not find among the bulletins of this station any that touch the subject of meadows and pastures. It is a very interesting and important subject, but, as you know, our people—very many of them ex necesitate rei—have been giving so much attention to cotton production that they have lost sight of live stock. Out of office hours, I am, and have been, trying to get a good word to the people through the secular press in the interest of more and better stock, and improved, labor-saving,

farm implements. With more live stock will come the demand for pastures and meadows.

ILLINOIS.—Prof. O. D. Center of the Illinois College of Agriculture, Urbana, Ill.: While the list of available grasses is long, there are a few that are always serviceable, and are of greatest value. These in the order of their importance for pasture grasses in Illinois are: Kentucky bluegrass (*Poa pratense*), redtop (*Agrostis vulgaris*), timothy (*Phleum pratense*), orchard grass (*Dactylis glomerata*), perennial ryegrass (*Lolium perenne*) and meadow foxtail (*Alopecurus pratensis*). This list includes only the true grasses that are of unquestioned value. It is also common to include in this list the clovers, medium red, alsike, and white, as well as alfalfa, which last mentioned certainly comes more truly under the head of meadow plants than those for pasture. We have such a diversity of soil types in Illinois that no one mixture will do for all locations. Classifying the soils as good land well drained, land of ordinary fertility poorly drained and poor soils, dry, gravelly and broken, we present the following mixtures for permanent pasture:

Good land well drained,

4 pounds Kentucky bluegrass	=Poa pratense
2 pounds Redtop	= Agrostis vulgaris
2 pounds Orchard grass	= Dactylis glomerata
3 pounds Timothy	= Phleum pratense
1 pound Meadow foxtail	=Alopercurus pratensis
1 pound Perennial ryegrass	=Lolium perenne.
2 pounds Alsike or white clover or a mixture of both.	

This variety of grasses and the amounts of each give a total of 15 pounds of seed per acre which will, taking the number of seeds per pound of the different sorts and the average per cent of viability into consideration, supply nearly 21,000,000 fertile seed per acre; this means that there are at least 450 seeds per square foot of surface. While we realize that it is often advised to sow twice as much seed per acre as here suggested, we contend that this seeding is sufficiently thick if sown on a properly prepared

seedbed. For permanent pasture on poorly drained land the following mixture is recommended:

5 pounds Kentucky Bluegrass	=Poe pratense
2 pounds Redtop	=Agrostis vulgaris
1 pound Orchard grass	=Dactylis glomerata
3 pounds Timothy	=Phleum pratense
1½ pounds Meadow fescue	=(Festuca pratensis)
2½ pounds Alsike clover	=Trifolium hybridum

Here again we have 15 pounds per acre of a seed mixture furnishing over 22,000,000 seeds—certainly a sufficiently heavy seeding for all practical purposes. For permanent pasture on poor soil, dry, gravelly, or broken, we suggest the following:

3 pounds Redtop	=Agrostis vulgaris
2 pounds Orchard grass	=Dactylis glomerata
4 pounds Sheeps fescue	=Festuca ovina
3 pounds Timothy	=Phleum pratense
4 pounds Italian rye grass	=Lolium Italicum
2 pounds White clover	=Trifolium repens

It will be noticed that this mixture contains a greater number of pounds to be sown per acre than either of the preceding. The number of viable seeds per acre, taking a good average per cent of germination for each sort, will be practically 23,000,000 or 530 per square foot of surface.

Meadows and Hay Land.—For meadows there are fewer sorts of grass used than for pastures. The old but incorrect idea that timothy is the best and most valuable grass for hay is still prevalent in too many sections of Illinois. Throughout the cornbelt, however, the clovers and alfalfa are more in evidence. On the poorer soils of the state, redtop is the staple grass for hay. It has been aptly put by one of the most successful and progressive farmers of this state that the common practice of soil depletion of Illinois progresses along the following lines: "Corn until the land refuses to produce profitable crops; then corn and oats, or corn and wheat, until the same limit is reached. After this condition prevails, clover is brought into use and another period of profitable cropping ensues until the soil refuses to respond readily, when timothy is substituted, and a series of years of timothy hay production follows. Presently, however, the timothy fails to yield a

profitable crop, and redtop is hailed as the savior of the land, and as the money-producer. This thought is soon dispelled, however, for redtop quickly ceases to pay for the labor of cutting and stacking, and the only recourse left for the thoughtless and careless farmer (?) is the poor house." This expresses the exact condition of the hay meadow situation throughout too large a proportion of Illinois. The well-cared-for meadows of the state consist for the most part of either pure timothy, clover and timothy mixture, clover and orchard mixture, or some one of the clovers alone. There is a very small number of farms in Illinois that even attempt to have permanent meadows. The extreme length of life of a hay field, if it is at all available for cultivated crops, is from 4 to 6 years. Where a field cannot be cultivated there is a decided tendency toward seeding it to alfalfa and making the most permanent hay land possible. True there are hundreds of acres of land in the southern part of Illinois which produce a ton or less of poor, weedy, redtop hay per acre, but these fields might better be classed as abandoned rather than as meadow lands.

Care of Pastures and Meadows.—Special attention to a pasture or to a meadow is one of the clearest indications of good farming. Where cultivation and fertilization of the grasslands of a farm are practiced, the grain crops and the live stock of the farm show careful attention and good breeding. The use of the disk harrow in the spring followed by a smoothing harrow has proved of especial value in keeping a pasture free from weeds and promoting the growth of grass. The same is true of meadows. When this cultivation is accompanied by the addition of plant food, such food as the soil indicates by response it is in need of, the growth and yield secured far outweigh the cost of labor and plant food applied. Carefully conducted experiments have proved that with a clover meadow the yield may be increased more than a ton per acre through cultivation and the application of phosphorus. (Steamed bone or raw rock phosphate). This is especially true on the land of the cornbelt of Illinois. While the effect is less marked with the timothy meadow, it is still sufficiently large to warrant the expenditure of labor and money for the application. Pastures respond markedly to like treatment, and not only give grazing facilities for a larger number of animals, but show the benefits of the cultivation and addition of plant food, when broken and put into crops.

Following is a method of determining amounts of various sorts of seed to include in a mixture:

Name.	Seeds per pound.	Per cent of germination.	Viable seed.
Kentucky bluegrass	2,400,000	60	5,750,000
Redtop	6,000,000	80	9,650,000
Orchard grass	600,000	70	800,000
Timothy	1,170,000	90	3,150,000
Meadow foxtail	900,000	50	180,000
Perennial ryegrass	340,000	90	300,000
White or alsike clover	700,000	80	1,120,000
Total	.....	....	20,900,000
Kentucky bluegrass	2,400,000	60	7,200,000
Redtop	6,000,000	80	9,600,000
Orchard grass	600,000	70	400,000
Timothy	1,170,000	90	3,100,000
Meadow fescue	400,000	80	480,000
Alsike clover	700,000	80	1,400,000
Total	.....	....	22,180,000
Redtop	6,000,000	80	14,500,000
Orchard grass	600,000	70	800,000
Sheeps fescue	700,000	70	1,900,000
Timothy	1,170,000	90	3,150,000
Italian ryegrass	300,000	90	1,080,000
White clover	700,000	80	1,320,000
Total	.....	....	22,750,000

INDIANA.—Prof. A. T. Wiancko, Agriculturist at Purdue University Experiment Station, Lafayette, Ind.: There is no doubt that timothy is our best meadow grass in this part of the country. Orchard grass has been considerably tried and advocated but in practice it does not seem to meet with much favor among farmers. I judge that this is on account of its form of growth, and its rather coarse stems. Meadow fescue and redtop have a place but they are comparatively unimportant beside timothy. Such grasses as Bromus inermis,

ryegrass and the oat-grasses are valuable under certain conditions, but they have found no important place in this part of the country. I believe, however, that there is a good field for investigation along this line and that the number of grasses that may be profitably used for meadows will be increased. Concerning clovers, it is our observation that for general purposes on an ordinary farm where ordinary rotations are followed there is nothing that can quite take the place of common red clover. There is very little else used in this state. Where soil improvement is the prime object in clover production I believe the mammoth clover has an important place, and some of our farmers are using it for that purpose with very satisfactory results; but where clover may be used for either hay or seed production, or both, the common red has the preference. I am of the opinion that alsike clover should be used to a greater extent for sowing in meadows with timothy, as it works in well with timothy and adds very materially to the quality of the hay produced. Alsike is grown for seed to some extent here, but a strong objection to it is that it is weak-stemmed and lies too close to the ground when sown alone. With a mixture of timothy this objection does not hold. Under favorable conditions in southern Indiana it is practically a perennial and in well-cared-for meadows should last a long time. Alfalfa is becoming quite popular here and will soon be one of the leading legumes grown for hay and pasture purposes. For permanent pastures there is nothing quite equal to Kentucky bluegrass, but in many cases it seems wise to mix some other grasses and clovers with it, especially in cases where the bluegrass does not grow luxuriantly at certain times of the year. In this way several of the grasses and clovers may find a place in permanent pastures. For temporary pastures, red clover with a little timothy in it is most popular. There are a number of annual crops that may be profitably used for pasture, especially for hogs. Among these are the cowpea and soybean. Our observations indicate that alfalfa will be more and more used for pasture purposes as people become better acquainted with it and learn how properly to treat it.

Kansas.—Prof. A. M. Ten Eyck, of the Agronomy Department of the Kansas State Agricultural College, Manhattan: There are no domestic grasses adapted for growing in central and western Kansas which will make good permanent pasture or meadow.

Kentucky bluegrass and white clover have been gradually introduced, and are becoming well established in the eastern and northeastern portions of the state; and, in fact, Kentucky bluegrass is about the only variety of domestic grass which is well suited for permanent pasture, and it must be associated with white clover in order that it may continue to thrive and make productive pasture continually for a number of years. Perhaps meadow fescue, commonly known in Kansas as English bluegrass, comes as near being a permanent meadow grass as any variety of domestic grass grown in this state; yet as a rule it is much more profitable to seed new fields every four to six years, and break up the old meadows, planting the land to corn or other crops for a few years before re-seeding to grass. As a rule, I do not advocate keeping the same land continuously in any kind of grass, either for meadow or pasture, provided the land can be used for other crops, and new seeding of grass can be secured without too much expense or difficulty.

Covering land with grass is nature's way of restoring to old worn-out soils the fertility and good tilth characteristic of good soils. The true grasses do not add nitrogen to the soil, as do clover and alfalfa, yet they are in a sense nitrogen-gatherers in that the nitrogen of the soil is collected and stored up in the soil in the form of humus. Thus grasses prevent the wasting of nitrogen and other plant food elements and serve to protect the soil and maintain its fertility. By their extensive and deep penetrating root systems, many grasses also tend to break up and deepen the soil, gathering and storing plant food in their roots, and thus actually increasing the humus and available plant food of the soil. The perfect tilth and freedom from clods so characteristic of virgin soils, is always more or less completely restored whenever soil has been seeded down to grass for a sufficient length of time. Grasses and legumes maintain the supply of soil nitrogen and restore the proper soil texture; besides they are profitable crops and, in fact, are absolutely necessary on every farm on which stock is kept. Pasture must be had on every farm, and it is quite essential that it be made a part of the regular crop rotation. Much more grass can be produced when pastures are kept fresh and new, and the increase of fertility and improvement of soil texture result in larger crops of corn and grain when the pasture is broken up and planted to these crops.

There is still much native grassland in Kansas, and if permanent

pastures and meadows are desirable these lands had better be left in grass, since there are no grasses better adapted for permanent pasture or permanent meadow in Kansas than the native grasses which grow on Kansas prairies. As yet we have not been able to domesticate these wild grasses so that they can be re-seeded successfully. Several of the native grasses are being grown by our botanical department with the idea of domesticating them and selecting improved varieties for propagation. The following are valuable and permanent wild Kansas grasses: Big bluestem (*Andropogan furcatus*), little bluestem (*Andropogan scoparius*), buffalo grass (*Buchloe dactyloides*), gama grass (*Tripsacum dactyloides*), Indian grass (*Chrysopogon nutans*), switch grass (*Panicum virgatum*), Prairie oats (*Bouteloua racemosa*), prairie grass (*Koeleria cristata* and *Katonia obtusata*), and short gama (*Bouteloua hirsuta*).

As pastures and meadows get old they become sod-bound and less productive, and this is true of wild grasses as well as of domestic grasses. The available fertility of the soil finally becomes exhausted and much of it is locked up in the immense root system which is developed by a thick growth of grass. With domestic grasses a new growth may often be secured by thoroughly disking and harrowing the sod early in the spring, and this method has also been successfully practiced with the native grasses. The disking has the effect of destroying part of the grass plants, whose roots soon decay, furnishing new food for the growth of the grass. The disking also breaks up the compact condition caused by the tramping of stock, and areates the soil, while the mulch of mellow earth acts to conserve the soil moisture, thus favoring the growth of the grass.

In order to get the greatest results, however, fertilizers should be applied along with the disking. No better fertilizer can be applied to grass than barnyard manure. The top-dressing applied in the fall or early winter serves as a cover to protect the grass roots from the extremes of temperature. As spring opens the water from the melting snow and rains carries the nutrients from the manure down to the roots of the grass, causing an early strong growth, which continues throughout the season. During the summer also, the manure acts as a mulch to keep the water in the soil, thus protecting the plants more or less from the influence of dry weather. There is no more convenient place to haul manure than on the grass land; there is no crop which responds more readily

and gives more profitable results from the application of manure than does grass; and it is not necessary to wait until the pasture or meadow is old and worn-out before making liberal applications of manure. It is my recommendation always to use grasses in rotation with other crops whenever possible. There are a number of grasses which are more or less well adapted for growing as rotation grasses in Kansas, and these may always be more or less permanent. Judging from the nature of the grasses and their general adaptation and the experience of farmers in growing them I have prepared the following list of grasses and combination of grasses and legumes as being suitable for meadow or pasture to the several divisions of the state:

For meadows in Eastern Kansas:

1. Timothy and Mammoth alsike or common red clover.
2. Orchard grass and common red clover.
3. Bromus inermis and common red clover.
4. Meadow fescue and common red clover.
5. Bromus inermis, orchard grass, and common red clover.
6. Redtop, timothy and alsike clover.

Central Kansas:

Nos. 2. 3, and 5, as named above.

7. Western ryegrass and Bromus inermis, with clover.

Western Kansas:

8. Bromus inermis, Western ryegrass and alfalfa.
9. Bromus inermis and alfalfa.
10. Bromus inermis.
11. Tall oatgrass.

For Pasture in Eastern Kansas:

1. Meadow fescue, orchard grass, Bromus inermis and common red clover or alsike clover.
2. Bromus inermis, timothy, redtop and alsike clover. (Especially on low lands.)
3. Bromus inermis and alfalfa.
4. Kentucky bluegrass and white clover.

Central Kansas:

5. Bromus inermis, orchard grass, western ryegrass and common red clover or alfalfa.
6. Bromus inermis and alfalfa.
7. Bromus inermis.

Western Kansas:

8. Bromus inermis, western ryegrass and alfalfa.
9. Bromus inermis.
10. Bromus inermis and Tall oatgrass (Tall oatgrass is recommended for western climate and light soil.

Combinations of grasses and perennial legumes are usually to be preferred to any single grass, both for meadow and for pasture. A combination of grasses is especially desirable for pasture, giving more continuous grazing, greater protection, more variety, and perhaps a better balanced food ration. In choosing grasses for pasture the object should be to choose such varieties that the deficiencies of one variety may be balanced by the good qualities of another. Grasses should be chosen which are different in their methods of growth and their dates of maturity, in order to lengthen the grazing period, and give the greatest amount and most continuous grazing. On the other hand, for meadow, grasses and legumes should be chosen which have the same maturing season, in order to make the best quality of hay. A combination of grasses usually makes a more perfect sod than any one grass will produce and a more permanent pasture or meadow. A little clover or alfalfa should be seeded with every combination of grasses, whether for meadow or pasture. The legumes are enabled, by means of the bacteria which work on the roots of these plants, to utilize the free nitrogen of the air, and thus tend to increase the supply of nitrogen in the soil, and act as host-plants or feeders to the nitrogen-exhausting grasses. It is very important therefore that every pasture or meadow should contain some perennial legumes, because the presence of these nitrogen gathering plants will not only cause a greater production from the other grasses, but it will make the pasture or meadow more enduring, and leave the soil more fertile than would otherwise be the case when the sod is finally broken for the growing of other crops. Carrying out this principle it is a good plan to seed clover or alfalfa in the native pastures and meadows. I have observed this tried in a few instances, and clover especially often

makes a good catch and is beneficial in helping to revive and renew the growth of the prairie grass. In establishing a grass meadow or pasture one of the most important factors is a proper seedbed. An ideal seedbed for grasses should not be deep and mellow, rather the soil should be mellow but finely pulverized only about as deep as the seed is sown; while below the seed the soil should be firm but not too hard and compact, making a good connection with the deeper subsoil. This offers the most favorable conditions for the germination of the seed and the growth of the young grass plants. The firm soil below the seed allows the capillary moisture to be drawn up to the seed, while the mellow soil above the seed offers the most favorable condition for the warming of the soil and the oxygen of the air to reach the seed; and these three factors, moisture, heat and oxygen, are essential for the germination of all seeds. Meanwhile, the mellow mulch of surface soil acts as a blanket to keep the moisture from escaping and at the same time gives the most favorable conditions for the delicate little plant to unfold and push upward into the air and sunshine, also the firm sub-surface soil gives the proper root-hold and environment which conduces to a rapid and strong growth of the young roots. Grasses, clover and alfalfa are not only much more likely to start poorly in a deep, loose seedbed, but even after starting, the young plants are much more likely to "freeze out" in winter or "burn out" in summer than will be the case in the shallow, firm-bottomed seedbed as described above.

Clover should be sown in the spring or early summer because fall-seeded clover and alfalfa are apt to winter kill.

Throughout a large part of Kansas grasses and alfalfa may be successfully seeded either early in the fall or early in the spring. On the whole perhaps the early spring seeding is safer, provided a good seedbed is provided and the land is not too foul with weeds. It is safest to sow almost all kinds of grasses and perennial legumes alone, or without a nurse crop. Always have the seedbed fully prepared before sowing the grass seed, so that little work will have to be done on the ground after seeding. If the seed is sown broadcast, one light harrowing after seeding is usually sufficient to cover the seed, and is preferable to several harrowings or any deep working of the soil after seeding. Grass seed should not be covered deeply, usually not more than an inch or so, or even less, depending somewhat on the soil and the weather conditions. A good seed-

bed may be prepared by disking and harrowing corn stubble land, or early fall plowing which has settled well makes a good seedbed for spring seeding. If it is necessary to plow shortly before seeding, the ground should be firmed by the use of a sub-surface packer or by repeated use of the harrow and roller. Along with a good seedbed do not fail to use the best quality of seed. The best is always the cheapest even at the higher price.

MICHIGAN.—Prof. R. S. Shaw, Director of the Michigan Experiment Station, East Lansing: The following grasses are most commonly grown in Michigan: Timothy, orchard grass, bluegrass and redtop. I doubt very much whether there is any one grass that is used more than bluegrass in this state. I would place timothy second, redtop third and orchard grass fourth. No matter what combination of clovers and grasses may be sown in this state, at the end of five or six years bluegrass will have taken almost complete possession to the total exclusion of the other sorts. Bluegrass takes possession here naturally, if given sufficient time, without any seeding whatever. Redtop is being grown only on low-lying lands or in connection with permanent pasture mixtures. Legumes most commonly grown are red clover, both mammoth and medium, alsike and alfalfa. The medium red clover is very largely grown in the southern part of the Lower Peninsula, while the mammoth is grown in the northern part of that region. Alsike clover is being used very largely in connection with red clover 6 to 8 pounds, timothy 2 pounds and alsike 2 pounds. It has become a very common practice to seed down for hay and pasture with a combination of this kind. The alfalfa area of this state is extending very rapidly. We have had a wide range of conditions here as regards soil and climate, and it has taken some little time to find out just how to handle this problem. Permanent pastures are to some extent fertilized by applications of well-rotted barnyard manure with the manure spreader as a top-dressing. I doubt very much whether any commercial fertilizers are used in this way and only a comparatively small amount of lime.

MINNESOTA.—Prof. Andrew Boss, Agriculturist of the Minnesota Experiment Station, St. Anthony Park: The best grass in my estimation for pasture in Minnesota is Kentucky bluegrass, especially where the pasture is to remain for any length of time. The second best is the Austrian Brome grass or Bromus inermis. Third,

timothy or preferably timothy mixed with a small amount of medium, alsike or white clover. There are few others that are of any value for pasture. In short rotations and in temporary pastures, the common mixture of grass seeding is timothy 6 to 8 pounds, medium red clover 3 to 6 pounds, white clover ½ pound per acre. For permanent pasture the seeding would be somewhat lighter of these grasses with 8 to 14 pounds of Kentucky bluegrass added. On our rolling prairie lands where drainage is good, any of these seedings will do well for pasture. On low wet lands preference is given to timothy, redtop and alsike clover. For the drier and sandier lands the Austrian Brome grass seems to be best adapted. The common hay crop in Minnesota is timothy or a mixture of timothy and alsike or medium red clover. All three grow in profusion on land that is in good condition. On lowlands redtop and alsike with a small mixture of timothy are in high favor. In securing a stand of these grasses it is customary to sow them in spring with the seeding of spring grains, preferably barley or spring wheat. Fall-sown rye or winter wheat also make a very desirable nurse-crop for grasses, the grass seed being sown the following spring. Splendid results are obtained in the management of our grasslands by top-dressing with barnyard manures. Both hay and pastures yield heavily to this treatment, though the application to the pasture should be made during the fall or early winter season.

Mississippi.—Prof. W. L. Hutchinson, Director of the Mississippi Experiment Station, Agricultural College: Bermuda and carpet grass are the two essential pasture grasses for this state. Lespedeza, which is a clover, is perhaps of more importance than either as a pasture plant, as it appears in almost every pasture in the state and ranges in importance from being essentially the whole thing along down to about 50 per cent. White clover is an important pasture plant. Bur clover is very much less so, but more so every year; that is, effort is constantly being made to increase the area of bur clover in the pasture. Lespedeza has spread all over this state by natural methods, very little having been planted, and because of this fact it appears in practically all pastures everywhere. It is a particularly valuable plant in the brown loam area in the western part of the state. This area extends from Tennessee to the Louisiana line, and the Illinois Central Railroad runs through it. Bermuda grass must be planted, and hence it does not appear over

nearly so large an area as does lespedeza, but where it has been planted one finds the Bermuda and lespedeza growing together, and this makes a better combination or better pasture than either plant by itself. In the southern part of the state carpet grass appears along the branch bottoms (what we are in the habit of calling draws) and like lespedeza spreads naturally, and in this section one will find carpet grass and lespedeza growing together. In the prairie section, in east Mississippi, on the worn areas thereof, particularly where there is considerable exposure of the lime rock, melilotus, commonly called sweet clover or bokhara, is an important pasture plant. On such areas, lespedeza makes the poorest stand, and in consequence is of less importance than on any other areas in the state; but even in these pastures it doubtless assumes a value equal to melilotus. The very best combination I know is Bermuda, lespedeza, white clover, bur clover and vetch on the same land; but the pasture area in this state on which one finds all of these plants is very limited indeed. To recapitulate, lespedeza is the universal pasture plant; Bermuda is essentially the pasture grass for this section, but as it must be planted it does not appear over our entire pasture areas by any means. It is not nearly so general as lespedeza. Just what area we have in Bermuda I do not know. Then comes carpet grass in the moist bottom lands in the southern part of the state, while other important pasture plants are white clover, melilotus, bur clover and vetch. Lespedeza, Bermuda, carpet grass, white clover and melilotus practically furnish the grazing in the pastures of this state, and if I should venture a remark I would say that lespedeza furnished more grazing than all of the others combined on account of its being everywhere and the other plants growing only on limited areas. Johnson grass and Bermuda are essentially our hay grasses. Other hay plants of importance are alfalfa, lespedeza, cowpeas, oats, wheat and sorghum. Soybeans should and may become an important hay plant. The universal hay proposition, applicable on every farm in the state, is wheat or oats sown in September and cut in the dough stage the latter part of May, then on the same land plant cowpeas or soybeans, giving two hay crops a year on the same land.

Missouri.—Prof. H. J. Waters, Director of the Missouri Experiment Station, Columbia: Our studies have been principally with timothy meadows. but I have made considerable study of

bluegrass pastures at the same time. I have been studying the life-history of the timothy plant in connection with our investigations of factors affecting the yield, and found, to my utter astonishment, that it is not a perennial, as is popularly supposed. That is to say, when a plant has sprung from the seed it does not have a period of some years of development, which would correspond to the youthful or growing period of an animal, and then a period of a few years of maximum efficiency and productiveness, which would correspond to the period of prime of life of an animal, and then a period of decline and debility, corresponding to the old age period of an animal. On the other hand, plants spring anew each year from the old bulb, and the bulb, after it has produced its new plant, dies. This new plant produces, in addition to its top which we cut for hay, a new bulb to carry the plant over the following winter, and this in turn produces a new plant and dies. So that the timothy plant is an annual in the same sense at least that a potato is an annual. These studies are the very basis of our knowledge of the management of meadows and pastures. To say in a few words what the best grasses and clovers for Missouri are is practically impossible because of the great variation of the soil both physically and chemically. Moreover, Missouri covers a distance of 300 miles from north to south in a portion of the country where the flora and fauna of the north and south blend. For example, cotton is grown quite extensively in the southern portion of the state and some spring wheat is grown in the extreme western portion. Broadly speaking, there is but one hay grass in Missouri, timothy, and but two hay clovers, the common red clover and alfalfa, with a large reliance in the extreme southern portion of the state on the forage plant, the cowpea for hay. Likewise, broadly speaking, there is but one permanent pasture grass for Missouri, and that is Kentucky bluegrass, and but one permanent pasture clover, namely, white clover, which comes into bluegrass pastures without seeding and covers the ground during the resting period of the bluegrass, thereby giving the crop a much higher nutritive value and larger yield. I have divided the state into nine principal groups, as follows:

1. The loess soil both north and south of the river which is open and friable and does not hold bluegrass well. This land, however is rich in lime and on it timothy thrives; so does red clover and

likewise alfalfa. Broadly speaking, the hay grasses are the three mentioned. The land is very valuable, and so far no permanent pasture is laid down as a rule, but the meadows are mowed for hay for one or two years then pastured for one or two years, cattle or hogs being fed on them and then broken up and put in corn for three or four years, then changed to oats for one year and again sown to timothy and red clover. 2. The black prairie soil of northwest Missouri and the best corn soil in the state. It is, however, of a little too coarse texture to produce bluegrass to the best advantage, although better adapted than is Region I, and is more generally used than is Group I, otherwise the practices of the two regions are identical. 3. Black limestone loam represents the highest development of bluegrass pastures in the state. The soil is capable of fully equaling the best bluegrass production in Kentucky. Here the pastures are permanent with large shade trees, the farmers breeding pure-bred stock to a large extent. The meadow grasses are timothy and red clover. Alfalfa does well on these soils and is coming to be more and more generally employed. 4. The same as 2, plus clay and finer and tighter, therefore better adapted to bluegrass than 2. Here the chief reliance is bluegrass and white clover, while the hay grasses are with perhaps less reliance upon alfalfa than 1, 2, and 3, and more reliance upon cowpeas. 5. A level prairie region with a very compact soil of close texture and is the timothy region of the state. The great bulk of the timothy seed produced in the state is grown in this region. Clovers are not so extensively used and cowpeas are more widely relied upon. In this region timothy meadows are kept for 10 years or more without being plowed, although the trend is away from this practice. 6. A lighter soil of coarser texture with some lime and not so well adapted to either bluegrass or timothy or the clovers as the regions just mentioned. Here considerable redtop, orchard grass and the larger fescues find much favor, both for hay and pasture with considerable reliance on the cowpea as a forage plant. 7. A limestone region in which red clover reigns supreme. The soil is of slightly too open texture for bluegrass to reach its best when first cleared. Continued tramping, however, rectifies this difficulty and ultimately this will also be a great bluegrass region. The chief reliance for hay here is timothy and red clover, and cowpeas. For pasture bluegrass and white clover in the older sections, and orchard grass and the tall fescues on the newer land, with the

native bluestem in the uncleared wilds. 8. The region for which we have not yet found a dominant grass. All of the grasses named, however, do moderately well, but there does not seem to be any one that is taking possession of the country as yet. 9. A sandy region in which Bermuda grass is practically the only successful pasture grass, and where alfalfa is the principal hay on the black waxy soils, with cowpeas on the sandier phases.

In all these regions in the wetter soils alsike clover is used instead of red clover and either English bluegrass (*Festuca pratensis*) *or* the tall fescues (*Festuca elatior*), or redtop (*Agrostus vulgaris*) is used instead of timothy. Likewise on the soils deficient in lime orchard grass or redtop is used instead of timothy, and cowpeas are used as a legume instead of red clover.

Oklahoma.—Prof. L. A. Moorhouse, Agronomist of the Oklahoma Experiment Station, Stillwater: Bermuda grass is the only grass that has given satisfactory results on our upland soils in this section, and I believe that this statement will apply to many districts in Oklahoma. We have tested practically all of the standard grasses in this locality, and we have failed to secure profitable yields on the higher lands of central Oklahoma. While I believe that good crops of Brome grass or timothy or possibly English bluegrass might be secured on many of our creek and river bottom areas, I have the opinion that these areas should be set aside for alfalfa. We could not hope to harvest more than 1½ to 2 tons of hay with any of the types I have mentioned, but when alfalfa becomes well set on such areas we can harvest at least 5 tons of cured hay per annum. We therefore recommend that our more fertile soils be set aside for the culture of alfalfa; Bermuda grass and white clover will make a satisfactory combination for the thinner upland soils. The cowpea can also be utilized on such areas. English bluegrass or meadow fescue has been grown to some extent in the north central counties of Oklahoma, and I am informed that it produces very satisfactory yields. I have visited a few farms where this type is used and can say that growers presented very favorable results. Brome grass, on the other hand, is used in the northwestern counties of the state, while Kentucky bluegrass, orchard grass and timothy may be found over on the east side. I am satisfied that some field tests should be conducted in the localities where these types have been introduced, and as soon as our district agricultural

schools are located we may have an opportunity to make further observations on growth of our standard grasses and clovers.

CONNECTICUT.—Prof. L. A. Clinton, Director of the Storrs Experiment Station, Eagleville: The best grass for pasturage purposes in Connecticut is Kentucky bluegrass. This is our natural grass which makes its appearance on all soils where the regular seeding fails, and it can be depended on with greater certainty than any other grass. For seeding down meadows, I recommend a mixture per acre of 8 quarts timothy, 6 quarts of redtop, 4 pounds of red clover and 2 pounds of alsike clover. For the first cutting this will give a larger percentage of clover hay. The second cutting should have a little clover, but it will be largely timothy and redtop. After a few crops of hay have been cut off if it is then turned into pasture it will be only a short time before it will be June-grass pasture, June-grass being Kentucky bluegrass.

Prof. E. H. Jenkins, Director of Connecticut Experiment Station, New Haven: The best grass in general for lawns and for pastures which are closely cropped in this part of the country I believe is the Rhode Island bent, a small variety of *agrostis vulgaris.* It will stand trampling, close grazing and dry weather better than any grass I know of, and makes sweet pasture. The yield is too small to make it a profitable hay grass. I have never seen the sheep's fescue used in pastures to any extent, but there are some strains of it that I have no doubt would make excellent pasture. Here timothy is universally grown where hay is to be sold, for it commands the best price, though redtop is known to be much more valuable for dairy use. Timothy and redtop are about the only grasses that are ever sown in this state. Occasionally one will find a farmer who has sown orchard grass in shady places and who makes some use of the meadow fescue in mixtures of timothy and redtop.

NEW HAMPSHIRE.—Prof. F. W. Taylor, Agronomist of the New Hampshire Experiment Station, Durham: A large part of New England and especially New Hampshire is naturally adapted to the growth of our most valuable cultivated grasses, timothy, redtop, bluegrass, orchard grass, and the common clovers, with the exception of crimson clover, find the soils and the climate here most congenial for a permanent home. This is attested by the fact that many pastures and meadows continue to produce fair yields of grass

and hay year after year without re-seeding. I have seen fields which have not been plowed for 30 or 40 years, and without the application of manure or fertilizer in the interim are still giving an annual production of a ton of hay per acre. I make this statement not as an approval of the practice but as an indication of the natural resources of the section for grass-growing. The best grasses for pastures, taking the state as a whole, in the order of their value and importance, are probably as follows: Kentucky bluegrass, timothy, white clover and wood meadow grass. For mowing lands or meadows the following are of most importance: Timothy, redtop, orchard grass and alsike clover. For re-seeding pastures the following mixtures would be recommended for seeding one acre:

Heavy moist soils: Timothy 5 pounds, redtop 8 pounds, orchard grass 4 pounds, meadow foxtail 3 pounds, white clover 5 pounds.

Light soils: Timothy 8 pounds, redtop 4 pounds, Kentucky bluegrass 8 pounds, orchard grass 8 pounds, white clover 4 pounds.

Orchards and shady places: Timothy 6 pounds, redtop 4 pounds, Kentucky bluegrass 6 pounds, orchard grass 8 pounds, wood meadow grass 2 pounds, white clover 4 pounds.

For re-seeding meadows the mixture per acre would be as follows:

Heavy soils: Timothy 10 pounds, redtop 4 pounds, red clover 6 pounds, alsike clover 4 pounds.

Light soils: Timothy 8 pounds, redtop 4 pounds, orchard grass 6 pounds, red clover 6 pounds, alsike clover 4 pounds.

With the object of determining to what extent, by what means and at what expense our pasture lands can be improved, the experiment station began a series of experiments last year to continue for a period of four years. The cost and relative merits of the following treatments are to be studied:

1. Harrow and re-seeding.
2. Harrowing, re-seeding and liming.
3. Harrowing, re-seeding, liming and fertilizing.
4. Plowing and re-seeding.
5. The pasturing of sheep.

Although no definite results can yet be approximated the indications from the first season's work are that plowing and reseeding constitutes the most economical method of pasture improvement.

A series of fertilizer experiments on hay land now in operation for three years indicate that nitrogen fertilizers especially in the

form of nitrate of soda are the most effective in increasing the yield of timothy and redtop, while wood ashes and the potash fertilizers seem most efficient in maintaining and promoting the growth of the clovers. While the application of lime has been strongly advocated by many, its use on the soils of the college farm and on various others in this section of the state has not proved markedly beneficial.

New York.—Prof. G. F. Warren, Professor of Farm Management and Farm Crops, New York State College of Agriculture, Ithaca: The one great hay grass in New York State is timothy, the second hay grass of importance is redtop. There are no other grasses of very great importance for hay production, although orchard grass, meadow fescue and several wild grasses are met with occasionally. The most important pasture grass is Kentucky bluegrass. Second in importance is timothy. Canada bluegrass is very common on the poorer lands. Redtop, meadow fescue and orchard grass occur to a considerable extent in pastures. Mammoth red and medium clovers are the most important legumes in the state. Second to these is alsike clover, and in all pasture mixtures white clover should be included. Where it grows successfully alfalfa is a most valuable hay plant for this state. For pastures a seeding of timothy, Kentucky bluegrass and white clover is always desirable. To this sometimes should be added redtop, orchard grass and meadow fescue. For hay production a standard mixture is timothy, mammoth clover, medium clover and alsike clover. To this redtop should be added under certain conditions. Alsike clover grows on land that is too acid or too poor for the growth of red clover; redtop grows on land that is too poor for the production of timothy, so that on the poorest lands, provided they are not manured and limed, it may sometimes pay to grow redtop or a mixture of redtop and alsike clover. Alsike clover is not grown quite so universally as it deserves to be. It is not so seriously affected by the root borer as red clover, and as stated will grow under more unfavorable soil conditions. Throughout this section of the state where there is limestone soil, alfalfa will grow readily. In practically every county in the state there are some soils on which alfalfa will produce an excellent crop, provided the land is limed, inoculated and manured.

Prof. Paul J. White, Assistant Professor of Farm Crops, New York State College of Agriculture, Ithaca: What are the best

grasses for New York State named in order for pasture? First, Kentucky bluegrass; second, timothy; third, Canada bluegrass; fourth, redtop. We have hardly arrived at the point where we can give definite instructions regarding mixtures for various soil types. Many letters from farmers regarding this matter come in. If I do not know the soil type I usually give them the following mixture: 10 pounds of timothy, 4 pounds of Kentucky bluegrass, 3 pounds of redtop, 3 pounds of orchard grass, 6 pounds of red clover, 4 pounds of alsike clover and 2 pounds of white clover. I do not include in this Canada bluegrass which I place third in value as a pasture grass. The reason is this: Canada bluegrass is thought by many to be a weed in pastures. However, throughout the sections of New York State where the soil has become impoverished there are large areas of which the principal grass is Canada bluegrass. This statement is true of the hill farms of southern New York, and of the formerly fertile clay or silt valleys of the Genesee Valley regions in Livingston county. If I were to place these in order of abundance of the grasses in general, I should place redtop before Canada bluegrass, but our experience with redtop has been that cattle avoid this wherever they can get any other grass. It seems to be unpalatable. However, if the farmer states that his land is inclined to be acid and poorly drained, I always recommend 3 to 4 pounds of redtop in the mentioned mixture. If I know that the field is fertile and will grow meadow fescue I recommend the growing of this in small quantities, say 3 to 4 pounds per acre. I find this grass present in pastures in the fertile sections of New York state. It is considered fine where it will grow.

I have included clovers in the mixture which I recommend. As to value, they will be arranged in the following order: First, red clover; second, alsike clover; third, white clover. This exhausts the list of clovers adapted to our conditions. I would arrange our grasses for meadows in the following order: First, timothy; second, redtop; third, Canada bluegrass. Timothy is the universal meadow grass in New York. We may say that it is always included in the new seeding unless clovers alone are sowed. Occasionally a farmer will use redtop. This, however, is not considered in the same class as timothy. It does not make a marketable hay. In the old meadows which have not been plowed for a number of years, especially on the hill lands of our state, we find a great deal of Canada bluegrass. They consider this a very superior hay grass for horses.

However, its market qualities are poor. It is never sown for hay, but it comes into the old fields which have not been plowed for a long time. On my own farm I cut 70 acres the past season of this grass. It yielded about one-half ton of hay per acre. This is worth on the market $10 per ton, while timothy is worth $13. We use red clover, either medium or mammoth, and alsike clover in meadows. No others are used. Usually about 10 quarts of timothy to 6 or 8 quarts of red clover are sown per acre.

Regarding the system of management and fertilization of meadows and pastures, I have but little to offer apart from the general practice of other sections. We consider that timothy should not be left down as a meadow longer than two or three years. The first year we cut a crop of clover, and the second and third years the hay is practically all timothy. We have been carrying on a series of experiments with farmers in connection with co-operative experiments which go to indicate that 100 pounds or so of nitrate of soda per acre will increase the yield of timothy hay more than enough to pay for the fertilizer and labor. This, however, we do not recommend to be applied to timothy meadows which are not at the present time producing more than a ton of timothy hay.

Under ordinary conditions I always recommend sowing timothy, Kentucky bluegrass and white clover. These are found growing naturally in all parts of this state, and on practically all kinds of soil. They may not be the principal plants occupying each type of soil, but they are there in greater or less numbers for permanent pasture. I think that Kentucky bluegrass should always be included in a new seeding because it will increase from year to year. White clover is a pasture plant which eventually appears in nearly all types of soil, but it should be sown occasionally. It is in and out and adds materially to the forage of pastures. I often recommend to farmers that they sow on their old pastures a light mixture of some of the principal grasses and clovers. I think from $1 to $3 worth of seed at a time will pay for itself and more in the course of a year or two. Prof. Samuel Fraser, manager of the Wadsworth Estate at Geneseo, sows from 60 cents to $1 worth of seed per acre. About 500 acres, he tells me, were thus reseeded last year. He states that he would prefer a light seeding to a heavy one. In case the seeding fails he can try again another year. If, however, heavy seeding had been applied the loss would be great. Without doubt the application of stable manure to our run-down pastures is of vast

importance in increasing their efficiency. As I often tell the farmer, he would not misuse his other crops as he does his pastures. For instance, he would not expect to get a crop of corn or timothy hay without seeding and fertilizing.

MASSACHUSETTS.—Prof. William P. Brooks, Director of the Massachusetts Experiment Station, Amherst: The best single grass for all pastures having soils fairly retentive of moisture is Kentucky bluegrass; and the best single clover is of course the white. There can be no doubt, however, that it is best to use a large variety of grasses in pastures. I have generally advised about as follows:

MIXTURES FOR PERMANENT PASTURES.

Variety.	Light soils.	Medium soils.	Heavy soils.
	Pounds	Pounds.	Pounds.
Timothy	3	4	3
Redtop	4	2	5
Orchard grass	8	8	4
Meadow fescue	4	4	4
Hard fescue	..	..	2
Tall fescue	2	2	4
Rough-stalked meadow grass	..	..	4
Kentucky bluegrass	4	4	5
Italian ryegrass	3	4	2
Tall oatgrass	..	4	..
Meadow foxtail	2	3	3
Yellow oatgrass	3	..	..
Sweet vernal	2	..	..
White clover	4	4	4
Alsike clover	1	2	3
Peavine clover	2	..	2

MONTANA.—Prof. F. B. Linfield, Director of the Montana Experiment Station, Bozeman: In our irrigated country we are using to a considerable extent mixed grasses for pasture. These seem to grow better at all seasons of the year and enable us to get the

maximum return from the land. On the average we find that it takes not quite an acre of land for the season to support one cattle beast with an irrigated pasture. Probably orchard grass, brome grass, English ryegrass are about the three best pasture grasses, but in our mixture we nearly always use in bluegrass timothy and tall oat if we can get it. Of the clovers the red, alsike and alfalfa we use, the former of course being in this climate biennial as a rule, and so does not persist for many years. The alsike and the alfalfa are persistent. We do not, however, like to have too much of these clovers, as with the luxuriant growth under irrigation there is some danger from bloat if the clovers predominate. For our dry-land country we have not yet determined to our satisfaction what are the best pasture grasses. The native grasses we find do not yield as well as some of our cultivated varieties, even on the dry bench lands. Alfalfa has been one of our most promising fodder crops and also pasture crops on the bench lands. Brome and tall oat grass also seem to do very well. There are other grasses which we expect to try, but are not yet able to advise as to their adaptability. In our studies on the bench lands the experiments so far conducted have not been continued long enough to warrant us in drawing very positive conclusions.

Nebraska.—Prof. E. A. Burnett, Director of the Nebraska Experiment Station, Lincoln: It is difficult to determine the best list of grasses and clovers for any region of Nebraska, and much more so for a region which would cover so large an area as one-half of the state. I have asked some of our leading farmers to give me their experience in the matter, a summary of which, along with my own experience would indicate something as follows:

Best grasses for pasture in the Eastern half of Nebraska: 1. Meadow fescue. 2. Bromus inermis. 3. Orchard grass. 4. Timothy.

Best grasses for pasture in the Western half of Nebraska: 1. Bromus inermis. 2. Western wheat grass, native. 3. Meadow fescue. 4. Grama grasses, native.

As you go north in the state, past the center, the district in which brome grass would be superior to meadow fescue as the best single grass would extend to the east. In north-central and northeastern Nebraska these two grasses would be of about equal merit and should be sown together. As a pasture mixture for eastern

Nebraska I would suggest 8 pounds of meadow fescue, 6 pounds of Bromus inermis or Bromus inermis and timothy, 2 pounds of red clover, 3 pounds of alfalfa and 1 pound of white clover. Omit white clover where pasture is largely for horses. Omit red clover and alfalfa where the land is extremely wet so that they will winter-kill. As a mixture for upland pasture in the western part of the state I would suggest 10 pounds of brome grass, 4 pounds of meadow fescue and 6 pounds of alfalfa. In valleys sow less alfalfa where cattle are to be pastured. For permanent meadows, alfalfa seems to be superior to all others when yield and value of hay are considered. Alfalfa does not seem to fit into a rotation of crops as well as clover, and where meadows are in a farm rotation in eastern Nebraska, 10 pounds of clover and 8 pounds of timothy hay make an excellent mixture, and furnish a high quality of hay. In southeastern Nebraska it would seem that bluegrass, where some mixture of white clover is present, furnishes one of the most valuable pastures, especially for early spring and for winter pasture where it has been allowed to grow up and mature before being pastured down. In the care and management of pastures it is apparent that the experience of all good farmers is against close pasturing at any season of the year, and especially so as the period of hot, dry weather approaches. Pastures should always have a sufficient amount of growth on them to protect them against burning sun and against the loss of water by run-off where it would be absorbed if there were sufficient growth on the ground.

The experience of our best farmers indicates that pastures should be mowed once or twice each year, first at the time when ragweed and other coarse-growing weeds begin to mature in late June or the early part of July, and second, if necessary, to get a few coarse-growing weeds in the early part of September, before they have ripened their seed. The experience of our farmers indicates that the application of barnyard manure with a manure spreader very greatly increases the productiveness of all upland pastures and probably of all pastures which are not liable to overflow from streams; that this manure can be applied at almost any season of the year but can best be applied during the winter season, beginning in late fall and continuing until growth starts in the spring. An annual application of manure to upland pastures has very greatly increased and has frequently doubled the stock carrying power of these pastures. It is good practice—where manure is applied to pastures—

to run over the land with a harrow and thoroughly break up and distribute this manure so that it shall not lie in clods upon the land, if it has not been evenly spread at the time of its application. The application of manure to meadows is as beneficial as to pastures, but where coarse manure is applied in the winter it should be thoroughly harrowed in the spring and the coarser parts raked off and removed, so that it will not damage the first cutting of hay.

Carl Rohde, Columbus, Neb.: My soil is all upland. The grass mixture which I sowed consisted of brome grass, 12 pounds; orchard grass, 6 pounds; meadow fescue, 6 pounds; alsike clover, 2 or 3 pounds; white clover, 1 pound. This pasture was seeded in 1904, and has proved quite satisfactory ever since. We have always been careful not to overstock it. I like the clover mixture in the pasture, although we lost one heifer in June, 1907, on account of it. As a general rule cattle will leave clover alone until it is matured and the other grasses get shorter on account of a hot and dry spell, which generally strikes us in the latter part of July and August. For fertilization we have practised top-dressing with a manure spreader, putting on about six loads to the acre. The effect of this was quite marked, and I recommend it where the soil conditions are similar. I do not carry more than one grown animal on every two acres of pasture, but at that rate we have kept cattle as well as pasture in excellent condition. The growth of the brome grass is quite pronounced and easily determined on account of the broad leaves and vigorous appearance, but I think that the other grasses fit in well with the mixture. Regarding clover, I consider alfalfa our stand-by, as it furnishes the best yield per acre, and seems to be just what we need for our stock, with the present high price of corn. Could we be sure however of getting a stand of red clover, by sowing in wheatfields in the spring of the year, I think it would fit in a little better with our crop rotation, especially when we consider the bad results obtained by a good many farmers during the past summer in plowing up alfalfa fields, and putting them into corn. If reports are true, these fields were the first to show the effects of the drouth. We do not like bluegrass for our upland; it does not attain sufficient length. It does all right in valleys.

William Ernst: Of all pasture grasses in southwestern Nebraska Kentucky bluegrass gives the most service if properly handled. If you have enough of it horses and cattle will live on it and thrive the year round if not covered with sleet or snow. The original

prairie grasses have practically all disappeared, killed out by the trampling of stock and the remainder was crowded out by Kentucky bluegrass and white clover. These are the pastures I like better than even the pastures of mixed grasses sown on cultivated lands and which finally run to bluegrass and white clover in the same manner as the native pastures mentioned and which seem to have stronger growth. The service and revenue of any pasture depend more on the handling than on the rainfall during the season. We did not think much of the Kentucky bluegrass until we learned how to handle it. We would turn the stock out onto the pasture, at the first starting of spring, before the grass was tall enough to get hold of it with their teeth, and see that all stock would be turned on that could possibly make a living on it. This being kept up until perhaps June would present on the more or less rolling land in eastern Nebraska a pasture of short, thick growth, on which an inch, two or more inches of rain would run off without soaking the ground one inch in depth; while in the adjoining cornfield the soil was soaked to such an extent that cultivation had to be postponed for two or more days. This condition would not change until fall rains and cooler nights brought some improvement. All this taught us that we must have a good growth of grass in any pasture in order to catch and retain the moisture necessary to have a good growth of grass during the season. A good bluegrass pasture wants fertile soil.

We handle our bluegrass pastures as follows: We turn our stock on as early as March when the new grass comes through the thick growth of old grass of the former season. Horses and cattle will do remarkably well until about May when they are turned onto the mixed pastures. In this way the stock does not know the change from dry feed to summer pasture. We now let our pasture rest until nearly harvest and mow the ragweeds that will be ready to cut the first week in July. If not cut they will greatly injure the stock, the horses in particular, in which the bloom-dust of the ragweed will produce an eye inflammation similar to pinkeye. This weed, if not mown, will greatly hamper the growth of grass, absorbing most of the moisture and holding down the growth, while if mown it will not be harmful to the pasture; on the contrary, it will act as a mulch and serve to hold up the tall, rank growth of bluegrass. The stock now may be kept on pasture until snow covers them, which is usually about the middle

of December. Stock is kept on these pastures only in sufficient number to leave plenty of grass to hold the snow. In this way we have nearly eight months of pasture from our Kentucky bluegrass.

We cannot keep the clover out, and while we do not think it improves the feeding value of the pasture, we do think it gives new life to the bluegrass, which is perhaps due to the nitrogen introduced in the soil by the clover. Horses in particular would be better off without the clover, as it makes them slobber. Clover and timothy make a good fall pasture. While we do not sow clover for that purpose, it naturally comes in in that way. We sow the clover for fertilizing purposes, sowing all our small grain to clover regardless of what the next crop may be. Spring sowing often gives 30 to 40 days' good pasture during August until plowed up for winter wheat, enough to pay for the seed. Alfalfa not fitting well in our rotation of crops, we set aside for meadow and hog pasture, with a partition fence to divide it into halves, mowing and pasturing, turn about; that is to say, mow one-half the first of one month and pasture the next and so on, turn about. A good all-round pasture was always obtained by sowing the following mixture:

Meadow fescue, 12 pounds; orchard grass, 4 pounds; brome grass, 4 to 8 pounds; timothy, 1 pound; red clover, 1 pound.

This mixture would be about right for central Nebraska. Going north I would increase the brome grass and decrease the meadow fescue in proportion; while going south I would reverse the change; that is, increase the meadow fescue and decrease the brome grass. These grasses may be sown with or without nurse-crops and if once established are quite drouth and heat-resistant. We have used, if convenient, the first growth for hay, but found it lacking in quality when compared with clover and timothy. The pasture of the mixture usually is good by May 1, and will last until killed by frost. It may be improved by mowing it high when seeds are formed by the principal grasses, but the clipping is usually worth as much when left to lie on the ground as when taken off for hay. It will renew the pasture from year to year and make a thicker stand and sod, which are both desirable for this mixture of grasses. Here again, the same as recommended for the bluegrass pasture, a big heavy top is at all times preferable to excessive shortness, as it will hold the moisture of the soil needed for big juicy growth of vegetation.

As to the relative feeding value of the three principal grasses, I have no positive knowledge, but know that they supplement each other admirably, for the reason that they do not ripen all at the same time. Meadow fescue after clipping or cutting for seed will remain tender and to some degree for a longer time than either brome or orchard grass. For real winter pasture there is perhaps nothing better than winter rye, unless it be Kentucky bluegrass, reserved for that purpose. Rye sown early in the fall on ground calculated for corn may be pastured closely until May 1, when a disk should be set to work and thoroughly kill it before planting to corn. All remaining rye will not help the corn; on the contrary, it saps the ground of moisture and is obstructive to good cultivation. Winter rye sown in the spring will not go to straw much before July, and has helped us out as hog pasture and has acted as a nurse-crop for grasses sown in the early spring. We have been able to pasture the spring-sown grasses right after mowing about July 1.

North Dakota.—Prof. J. H. Shepperd, Director of the North Dakota Experiment Station, Agricultural College: Timothy, brome grass and redtop have the field for meadow and pasture production in this state. Brome grass finds its place in the drier districts where timothy does not succeed, and where it in turn is readily killed by ordinary cultivation operations when the grower is through with it. Redtop is utilized for wet land that is subject to flooding. Bluegrass is highly valued here as elsewhere for lawn-producing purposes, but it is only a fair success where water cannot be procured for it, in the eastern part of the state, and is a failure in the dry-land districts where an artificial water supply cannot be administered. Red clover is the most successful of the entire group of its kind and is seconded by alsike. Mammoth clover survives here, but is not so satisfactory as the common red strain. White clover is used in connection with bluegrass for growing lawns.

Ohio.—Prof. Chas. E. Thorne, Director of the Ohio Experiment Station, Wooster: We are comparing grasses in a small way, but thus far have found nothing that would encourage us to expect from it any superiority to our old and long-tested bluegrass and redtop. Next to these I would place the tall fescue from my personal experience with it before the station was established. It is especially adapted to redtop soils and possesses some points of con-

siderable superiority, starting earlier in the spring and giving later pastures in the fall. The only objection to this grass is the greater expense of the seed and the difficulty of getting pure seed, as the seedsmen are disposed to substitute the inferior meadow fescue, or even the English perennial ryegrass, which, while a splendid grass in England, has not given similar results in our work by a long way. My advice, therefore, has been to sow for permanent pastures a mixture of timothy, medium red clover, alsike clover, Kentucky bluegrass and redtop, the idea being that the red clover will occupy the land practically but one year, and will leave additional fertility for the grass following. The timothy will generally disappear within two or three years, and by that time the redtop and blue grass will be ready to occupy the land. The alsike seems to be better adapted to moist situations and to be a little more permanent in its character than the red clover. I am convinced that our permanent meadows and pastures need regular and systematic fertilizing just as much as do the grain fields, and that one serious defect in our system of agriculture is the neglect of this point. I regret that we have no definite experiments on this point, such as we have in the management of cereals. We are now instituting a series of experiments in the renewing and improving of pastures, similar to those in progress in Scotland.

Oregon.—Prof. James Withycombe, Director of the Oregon Experiment Station, Corvallis: There are many native grasses in this state, but few are of much economic value. Among these are the bunch grasses (*Agropyron, divergens* and *spicatum*) and the sheep fescues. The former are found in the range districts of eastern Oregon and the latter are practically distributed all over the state. The bunch grasses, however, cannot withstand severe grazing, consequently are in a large measure destroyed. After the destruction of the bunch grasses the festucas make their appearance. The station has tested about 150 varieties of grasses collected from all parts of the world. Many of these did well, but only a few were considered of especial value. Among the very best for western Oregon are English ryegrass, Italian ryegrass, orchard grass and meadow fescue. These are the best for both pasture and hay. For seeding meadow land it is well to add a small amount of timothy, redtop and Kentucky bluegrass. Kentucky bluegrass does well on the irrigated or moist soils of eastern and southern Oregon,

which are usually well supplied with lime. There are some 17 native varieties of clover found in Oregon; thus the common varieties of clover do well. Red clover of course is the best, then come alsike and white. Crimson clover has not been very successfully grown. If it can be germinated early in the fall it will make a good crop. Alsike clover does remarkably well on what is locally known as "white land." This is a whitish clay land, very wet during winter and practically devoid of humus. Where a seed crop is not desired the red and alsike clovers are sown together and the combination makes a very desirable hay.

Clover is usually sown in the spring with grain, although some of our best farmers sow it alone or with about 1 pound of rape seed per acre. This latter method is very popular in some districts on account of the excellent fall pasture it affords for sheep and other small stock. Another popular method for a somewhat permanent pasture or meadow is to sow the clovers in the spring and the grass seeds the following fall. Another popular system is to sow red clover in the spring and timothy in the fall. This is usually done for hay. The first hay crop is clover, the next is half clover and half timothy and the next is practically clean timothy. Gypsum is wonderfully helpful to all of the legumes, so the general practice among our better farmers is to sow from 50 to 75 pounds of gypsum per acre each spring on all of their leguminous crops. This practice has been found good in pastures, particularly when clover is present.

Little work has been done in this state in the way of rejuvenating pastures and meadows. Some of our more progressive farmers have secured excellent results from the application of a light coating of barnyard compost, disking and where needed re-seeding, which is covered by harrowing. This should be done early in the fall so that the first general rains will germinate the seeds. Overpasturing is the bane of the meadows and pastures. Close grazing during the dry period is very destructive to the better grasses and clovers.

Rhode Island.—Dr. H. J. Wheeler, Director of the Rhode Island Experiment Station, Kingston: For ordinary open uplands the best grasses for Rhode Island are timothy (*phleum pratense*) and redtop. Common red clover and particularly alsike clover are also very desirable. From my experience, orchard grass is only

to be recommended for use where there is more or less shade and in somewhat moist lands. For land which is too moist for the best success with some of the other grasses tall meadow, oatgrass, bromus inermis and meadow fescue can be successfully grown, and I wish to lay particular emphasis on the last one. For pasture purposes in this state I consider Kentucky bluegrass and Rhode Island bent the best, though Kentucky bluegrass will not succeed generally without the use of lime or wood ashes, while Rhode Island bent will grow on our natural soil very readily.

South Carolina.—Prof. J. N. Harper, Director of the South Carolina Experiment Station, Clemson College: Bermuda is without doubt our very best grass. It makes a splendid pasture and can be grazed for about seven months during the year. It withstands drouth well and loves sunlight. As it does not seed in this climate it is propagated by planting the underground stems. The early spring is the best time to plant it. The best way to start Bermuda is to lay off 3′ rows with a turning plow. Drop the particles of Bermuda in these furrows about every 10″ to 12″. Bermuda should follow bur clover, vetch, cowpeas, soybeans or beggar weed. At the time the plants are dropped in the open furrows, 100 pounds of acid phosphate, 50 pounds of kainit and 150 pounds of cottonseed-meal should be applied in the furrow and then covered with a turning plow by running one furrow. About April 15, the following year, 75 pounds of nitrate of soda should be applied as a top-dressing. The second year after planting, plow shallow with a light turning plow or disk harrow and sow cowpeas, cutting the cowpeas off in the early fall. This should be repeated about every third or fourth year. Bur clover planted in Bermuda pasture also greatly benefits it.

The best time to harvest Bermuda is just after heading. In this climate it is usually ready to begin to pasture with hogs and sheep about June 1. On our bottom lands it makes a splendid meadow grass. Bermuda pastures and meadows should not be allowed to remain in grass except in permanent pastures more than 10 years. Bermuda is rich in carbohydrates and almost as good as timothy hay. It is of great benefit to our soils because it fills the soil with humus and fibrous roots. The underground stems are perennial; the plant is annual. Its worst enemy in our pastures is the paspalum grass. It is a heavy feeder on nitrogen. We get an average of from 1 to 5 tons of hay from rich bottom soils.

Texas bluegrass (*Poa arichnifera*) is another grass well adapted to this section. The sod should be planted in October or November or March or April. Plant the same as Bermuda. The rotations should be the same as Bermuda. It should be fertilized about the same as Bermuda except it is well to use nitrate of soda, about 50 pounds per acre at the time of putting out the sod. It should be cut for hay when in full bloom. It does not make a very good hay and should be used entirely for pasturing. The rootstock is perennial; the stem is annual. Its weed enemies are broom sedge, Bermuda, burdock and sour dock. It is a heavy feeder on nitrogen. The source of seed should be southern Texas. It is best adapted to a clayey soil or sandy loam with clay subsoil.

Bur clover is perhaps one of the best clovers for this country. While it does not afford very good grazing, it is one of our greatest soil-improvers. This year I obtained 50 bushels of seed from one-third of an acre. The seed was harvested the middle of June. I have now growing on the patch, corn, cowpeas, German millet and sorghum and these crops are as fine as I ever saw on the rich soils of Kentucky.

Crimson clover is also a splendid clover. It makes good hay and puts the soil in good shape. Japan clover or lespedeza is a splendid pasture clover. Red clover can be grown with us after the land has been made rich. White clover is a very good plant for our pastures. It does well in a pasture of Texas bluegrass. Orchard grass probably comes next to Texas bluegrass. We get from 1½ to 2 tons of hay on our soils that have been improved. Redtop also does well, and Johnson grass, while it is a pest in our cornfields, is a splendid meadow grass. We get from 2 to 3 tons per acre, and sometimes as much as 4 tons on our rich bottom lands. I would place the legumes in this order: Cowpeas, soybeans, Russian vetch, Florida beggarweed, bur clover, and crimson clover.

North Carolina.—Prof. B. W. Kilgore of the North Carolina Department of Agriculture, Raleigh: The best grass for pasture in the eastern two-thirds of the state is unquestionably Bermuda. We can hardly say there is a second-best, though Japan clover or lespedeza with Bermuda will likely occupy second place. On our low, wet and valley lands which furnish most of the pasturage for the eastern two-thirds of the state, there are a number of native grasses which give good pasturage. For the western third of the state

bluegrass stands first, with redtop second and timothy or tall meadow oatgrass third and fourth. For the Piedmont and mountain sections we recommend red clover, timothy and redtop. For the eastern or sandy portion of the state we recommend Italian rye and tall meadow oatgrass for hay. As to clovers for the Piedmont and mountain sections, red clover stands first and for the eastern part crimson clover, though crimson clover is grown as a winter crop to a considerable extent in the mountains and in the Piedmont section.

For the coastal plain section the best grasses for pasturage purposes are Bermuda grass (root cuttings), redtop, orchard grass, white clover, Japan clover, mammoth clover, alsike clover.

Mixtures for permanent pastures are, No. 1: Bermuda grass (root cuttings). One every 12″ in 2′ furrows. Cuttings should be about 4″ long. Japan clover, 12 pounds. No. 2: redtop, 20 pounds; mammoth clover, 10 pounds. Seeding per acre 30 pounds. No. 3: Orchard grass, 10 pounds; redtop, 10 pounds; tall meadow oat, 7 pounds; meadow fescue, 7 pounds. Seeding per acre, 34 pounds.

For a permanent pasture in low woodland, No. 1: Redtop, 14 pounds; perennial rye, 10 pounds; tall meadow oat, 5 pounds; alsike clover, 5 pounds. Seeding per acre, 34 pounds.

Grasses for pasturage purposes in the Piedmont and mountain sections: Redtop, timothy, orchard grass, bluegrass, mammoth clover, alsike clover, white clover, red clover.

Best grasses for meadows: Redtop, fodder grass, bluegrass, meadow fescue, orchard grass, tall meadow oat, Japan clover, mammoth clover, red clover, alsike clover.

Mixtures for permanent pasture, No. 1: Orchard grass, 10 pounds; tall meadow oat, 10 pounds; bluegrass, 5 pounds, red clover, 5 pounds. Seeding per acre, 30 pounds. No. 2: Orchard grass, 10 pounds; redtop, 10 pounds; bluegrass, 4 pounds; red clover, 6 pounds. Seeding per acre, 30 pounds. No. 3: Timothy, 10 pounds; meadow fescue, 5 pounds; bluegrass, 5 pounds; mammoth clover, 10 pounds. Seeding per acre, 30 pounds.

For meadows, No. 1: Timothy, 14 pounds; redtop, 10 pounds; mammoth clover, 6 pounds. Seeding per acre 30 pounds. No. 2: Redtop, 25 pounds; alsike clover, 5 pounds. Seeding per acre, 30 pounds.

For permanent pastures in woodland (mountain sides), No. 1: Orchard grass, 14 pounds; redtop, 7 pounds; tall meadow oat, 6

pounds; bluegrass, 3 pounds; red clover, 5 pounds. Seeding per acre, 35 pounds.

For permanent pasture in creek bottoms and other low lands, No. 1: Timothy, 14 pounds; redtop, 10 pounds; alsike clover, 6 pounds. No. 2: Redtop, 24 pounds; alsike clover, 6 pounds. Seeding per acre, 30 pounds. No. 3 : Redtop, 14 pounds; meadow fescue, 10 pounds; white clover, 6 pounds. Seeding per acre, 30 pounds. No. 4 : Redtop, 14 pounds; tall meadow oat, 10 pounds; fowl meadow fescue, 6 pounds. Seeding per acre, 30 pounds. No. 5: Redtop, 14 pounds; tall meadow fescue, 10 pounds; Canada bluegrass, 6 pounds. Seeding per acre, 30 pounds. No. 6 : Tall meadow oat, 24 pounds; alsike clover, 6 pounds. Seeding per acre, 30 pounds.

Wyoming.—Prof. Aven Nelson, Secretary of the Wyoming State Board of Horticulture, Laramie: Until within comparatively recent years we have depended very largely on the native grasses both for pasture and for meadow. Now, however, we are growing a number of standard grasses in meadows and to some extent pastures are being made. Of the introduced grasses I think timothy takes first place as a hay grass and bluegrass and redtop as pasture grasses. It is scarcely worth naming any legume other than alfalfa. It is grown very extensively now and is without doubt our most valuable forage plant. Red and alsike clover are also used, but hold a distinctly secondary place.

Texas.—Prof. H. H. Harrington, Director of the Texas Experiment Stations, Fort Worth: We have no grass comparable to Bermuda in all that part of the state where rainfall is sufficient to produce a proper growth, say east of the 100th meridian, or where rainfall of from 22 to 25″ exists. West of this line where the rainfall is lighter, the various mesquite grasses and grama grass are the best grazing grasses. A variety of the mesquite known as Tobosa along the plains and valleys north and east of Davis Mountains is an excellent pasture grass and makes a good quality of hay, the hay being preferred by liverymen to alfalfa; but when the grass gets dry in the field in winter it becomes very tough, and of course less valuable. Where the rainfall is more, rescue grass and bur clover succeed well and a mixture of these sown in alfalfa sod makes desirable pasturage. The bur clover serves for winter grazing, and early in the spring the rescue grass comes up in the

clover, and this is followed by the Bermuda. Lespedeza, or Japan clover does fairly well in the eastern part of the state. It like Bermuda is especially valuable to prevent hillside washing. It will grow on very thin land and thrives on such land much better than Bermuda, but it requires more rainfall and more sunshine to succeed best. In the Panhandle, orchard grass and Kentucky bluegrass do well. I would put Bermuda as the best for pasture in the central and eastern part of the state. In the western part the mesquite grass and in the eastern part crab grass perhaps would be second to Bermuda, this to follow rescue grass in the spring. Lespedeza for summer pasture and bur clover for winter pasture among the clovers. Of course where alfalfa can be grown it is the best pasture clover, especially for hogs and almost equally good for horses; but Bermuda has so much wider adaptability that it is superior even to alfalfa in general utility. Crab grass requires considerable rainfall. It is of course in the nature of a farm pest, especially detrimental to alfalfa. At the same time it affords good fall pasturage and makes an excellent hay.

For meadows, Johnson grass is perhaps superior to all others. Buffalo grass or Colorado bottom grass makes an excellent hay, but its growth is confined mainly to the southwestern part of the state. It comes up as a volunteer in the cornfield after the last plowing; is cut after the corn has been gathered, and is frequently more valuable than the corn crop; but if put in a meadow alone at least 2 cuttings or perhaps 3 can be obtained. We have had most excellent success with it at our Beeville station. In every part of the state sorghum is a valuable hay plant. A mixture of native grasses in the black prairie belt of the state, especially about Forney, furnishes a valuable hay. This is true also of the coast prairie belt from Beaumont to Victoria; but south Texas hay is very much less valuable than the north Texas hay, from native grass. Practically nothing has been done in this state in the way of fertilizing hay meadows, but what has been done leads clearly to the conclusion that cottonseed-meal scattered broadcast in the fall of the year, or late winter, will give most beneficial results—300 to 500 pounds per acre. Texas is so large with a corresponding variation of soil and climate that it would be difficult within the limitations of a letter to give more explicit information.

The most favorable grass for summer pasture that we have is Bermuda, although alfalfa after it has been established two or three

years and when it can be irrigated will stand rather heavy pasturage, and hogs and horses especially do remarkably well on it. I recently witnessed in the Toyah Valley 30 mares with foal running on alfalfa as an exclusive feed, and the mares were seal-fat, with udders like those of milk cows. For a winter pasture, bur clover is excellent from Waco south in the rainbelt, for hogs and cattle. Horses eat it indifferently. Rescue grass in the early spring is excellent pasturage. In the northwestern part, especially where irrigation can be practiced, Kentucky bluegrass does well.

Prof. H. Ness, Horticulturist of the Texas Agricultural Experiment Stations, College Station: I send you a list of a few important grasses with such extemporary notes and remarks as I can make in a very short time. Curly mesquite is found over the entire prairie district from Parker county west and south clear to the foothills of the Rocky Mountains. It grows to be about 6″ to 12″ high; is a runner, forming a dense sod. As pasture grass for the arid West this has no superior, inasmuch as it cures into the best of hay in a dry season, recovers itself and is succulent and green in a very few hours after a shower, and is exceedingly nutritious. Its power of resisting drouth is remarkable. The leaves may dry and curl; hence the name "curly", and the stems may dry until they burn as easy as hay, and are actually dead, but the joints preserve the vitality very much after the manner of seeds, and are evidently store-houses of nutritive matter that readily become useful as propagators of the plants after a rain.

Paspalum dilatatum, Poir, is found mostly in the eastern half and agricultural portion of Texas, especially on wet prairies, where it makes a quick growth very early in the season, continuing to grow until frost, so long as moisture is abundant. It is a perennial, but is not a runner. The stems are ascending and the foliage very heavy, with large, succulent leaves. This is one of the best pasture grasses and also meadow plants of eastern Texas. It is an especially good meadow plant where the land is too wet for ordinary crops.

Carpet grass is found over the moister portion of the coast country clear to the Red River, throughout the forest belt of east Texas. It is common in low, wet, open places, and seems to delight especially in a compact, close soil. It starts growth very early in the spring and frequently remains in green and growing condition until Christmas, or until killed by severe frost. It is a runner and affords a sod so thick that no other grasses or weeds

can readily get a good hold on the same ground. Like all other grasses, however, it avoids shady places, yet it constitutes the principal native pasture plant, as well as meadow plant, for east Texas. This grass derives the name "carpet grass" from its carpet-like sod. Cattle relish it very much, even more than they do Bermuda grass and very much more than they do *Paspalum dilatatum.*

Buckley is called the "Colorado bottom grass" in Texas. It is an annual about 3′ tall and is generally found throughout plowed ground over a large portion of middle Texas, especially the black land between the Colorado and Brazos Rivers. In this district it is highly prized as a hay plant, as it furnishes one of the most nutritious hays and very abundant yields. It readily reseeds itself, and starts its growth in June. It may readily be cut several times during the summer in the rainy season before the root is exhausted.

Para grass is a very coarse but nutritious annual 3′ to 6′ tall. It has especially taken hold of the alluvial irrigated lands of the western coast country. It is not very much cultivated in Texas due perhaps to the fact that the people are not well acquainted with it, but in the Rio Grande Valley it speedily occupies all cultivated lands not continually plowed during the summer, giving immense crops of the very best hay.

Bouteloua Oligostachya, is one of the many so-called "grama-grasses" of the western plains. It is a perennial and a bunch grass, but the bunches crowd each other so as to form almost a continuous sod. It is perhaps one of the most abundant and highly prized grasses of the cattle-raising belt, having the same quality of the grasses of the arid region, namely, curing into hay during the dry weather and speedily recovering its green and succulent nature after a shower. Besides this, there are several other species of *Bouteloua,* all highly valued by cattlemen, and nearly all covering the same area; that is, the great plains west of the 100th meridian.

Buffalo grass is found in great abundance over the great prairies west of the so-called "cross timbers" in Texas. It is a low, compact growth, giving a patch of it the appearance of a well-cared-for lawn, inasmuch as the leaf shoots only reach the height of 4″ to 6″, but the herbage is abundant, as it is very dense. This grass besides being one of the most highly-prized pasture plants of Texas, is exceedingly suitable for lawn purposes. It has a vivid green color and even growth, which makes it superior for that purpose to

Bermuda grass, and also the fact that it is readily killed by cultivation. It can stand a great amount of tramping and drouth. In appearance it is similar to Bermuda grass, except that the leaves are more narrow, and the shoots of more even height. The two grasses can readily keep the same area without being one too strong for the other. The only difficulty with this grass is that it produces seed in such small quantities that its distribution and propagation are carried on by means of pieces of sod or runners. Otherwise, it would undoubtedly be preferred to Bermuda. It can also grow outside of the arid region. Here at College Station, with a rainfall of 36″ annually, I have found dense patches of it holding its own against the other grasses.

Utah.—Prof. Lewis A. Merrill, Director of the Utah Experiment Station, Salt Lake City: In recent years we have found that brome grass is the very best grass we can grow on our arid lands. It was introduced in the state some 12 years ago, and its growth has been gradually extended until now there are thousands of acres of land lying above the irrigation canal seeded to brome grass. We find that it is absolutely essential to get a good seedbed before seeding. If we attempt to seed it on the barren hillsides without preparation of a proper seedbed the result is a failure. However, where the seedbed is properly prepared and the seed drilled in at the rate of 12 to 15 pounds per acre we get an excellent stand. The grass yields when cut for hay from 1½ to 2½ tons per acre. It makes a splendid aftermath, and thus makes a very profitable growth for cheap lands. We have tried a large number of grasses on these arid lands, including *Agropyron spicatum, Elymus triticoides, Elymus condensatus;* also orchard grass, tall meadow oatgrass, and perennial ryegrass. None of these has given satisfaction. They have not made a good stand, and after six years' experimental work with these varieties on arid lands we have come to the conclusion that brome grass is practically the only one of the list that we can recommend to our farmers for arid lands. We have tried brome under irrigation, but we prefer some other grasses under these conditions.

For a pasture grass under irrigation we have found none that begins to equal in importance Kentucky bluegrass. It stands at the head of the list as a single grass for pasture under irrigation. As a second choice under irrigation, I would place brome grass. I am

free to say, however, that in my opinion we would make a very serious mistake, on our irrigated lands, if we confined ourselves to one or two grasses. For our benchlands under irrigation I would recommend the following mixture: Kentucky blue grass, 6 pounds; meadow fescue, 3 pounds; perennial ryegrass, 7 pounds; red clover, 2 pounds; redtop, 6 pounds; orchard grass, 3 pounds; white clover, 2 pounds; lucern, 2 pounds. This mixture is used on our experiment station pasture.

For light sandy soil under irrigation I would use the following mixture: Kentucky bluegrass, 8 pounds; meadow fescue, 16 pounds; tall meadow oatgrass, 5 pounds; Bromus inermis, 5 pounds; white clover, 2 pounds. For our low moist lands we have found the following mixture gives excellent results: Perennial ryegrass, 8 pounds; redtop, 10 pounds; Rhode Island bed grass, 4 pounds; meadow fescue, 2 pounds; timothy, 2 pounds; alsike clover, 5 pounds; white clover, 2 pounds.

Of course for meadow the crop mainly grown here is timothy and clover. Hay from meadows of this kind sells at from $10 to $12 per ton, while alfalfa in good condition sells at $5 to $6 per ton. I think this is a mistake, but it is the practice here. I much prefer a ton of alfalfa for feed to any of the domestic animals to a ton of timothy or redtop. A number of our farmers make a practice of seeding orchard grass with alfalfa, since orchard grass matures about at the same time, and it is claimed that because it dries so readily it absorbs part of the moisture from the alfalfa and enables them to put it into mounds greener than if the alfalfa is sown alone. We have found it a very desirable practice to cover our pastures with well-rotted barnyard manure at the rate of about 15 tons per acre once in three years. The manuring is done during the winter season, and in the spring a sharptoothed harrow is run over the ground two or three times, scratching the surface very thoroughly.

We find it necessary about once in three years to reseed, and this is done after the harrowing, and just before the spring rains begin. Our alfalfa fields can be renewed and kept in splendid condition by the use of the disk harrow. The field is thoroughly disked and cross-disked along in February or March, and the practice of disking again after the removal of the first crop is gaining many advocates. During the past few years there has been introduced in this state a pest to the alfalfa crop, the alfalfa weevil.

Our entomologist recommends the disking of alfalfa fields after the removal of each crop in order to exterminate the insect. The practice has been found effective in destroying the insect and has also resulted in renewing the fields in a splendid way.

WASHINGTON.—Prof. R. W. Thatcher, Director of the Washington Experiment Station, Pullman: Alfalfa is the leading hay plant in all our warmer irrigated belts that are not used strictly for fruit-growing or vegetable-gardening. It is also becoming more and more prominent in the southeastern part of our state for both a pasture and a hay plant for hogs and what few cattle our wheat-farmers may keep. It is just beginning to be grown in the western part of Washington and enough has been done to show that all that part of our state seems to need inoculation for alfalfa, but that it will do well on any of the well-drained soils of western Washington if such inoculation is given. I believe that it will become a very prominent hay and pasture plant in western Washington. Nothing has been done thus far in the matter of fertilizing for alfalfa. The usual practice is to seed without a nurse-crop.

Clover is a very important forage plant in western Washington, and is just beginning to be grown to a very limited degree in the easternmost part of the wheatbelt where the rainfall is above 20″ per annum. At Pullman our trials on the experiment station have shown clover to be as valuable as alfalfa in short rotations, as the yield has been about equal to that of alfalfa and it is got rid of by plowing while alfalfa requires persistent cultivation before it is conquered. To secure a stand of clover with certainty in eastern Washington, however, it is necessary to prepare the seedbed in the spring in such a way that a good, firm bottom will be secured with a shallow, mellow surface mulch, then seed with an ordinary grain drill, slipping the spouts of the drill from the grain box onto the grass seedbox conducting the clover seed into the shoes of the drill, then setting the shoes to run shallow. In this way the seed is placed where the little seedling will not be destroyed with one or two hot drying days. Seeded in this manner we find no more difficulty in securing a stand of clover than of oats. With the frequent rains that occur in the early part of the season in western Washington such special pains are not necessary in seeding.

Alsike clover is useful in our state in very limited acreages where the drainage is poor or the land is subject to overflow the

early part of the season. Timothy is grown quite exclusively along the streams close to the mountains in both the eastern and western part of our state. This grass is used very largely for hay. In Kittitas Valley irrigated land is largely used for this purpose. With easy transportation to a good market like Seattle the better farmers in Kittitas Valley are able to secure some seasons nearly $100 an acre gross receipts from their timothy hay. It is grown to some extent in western Washington, though certain other grasses are grown in western Washington more proportionately than in like latitude in any other part of the United States.

For pasture, our best grass is orchard grass, which is grown principally in the western part of the state, but it is being mixed with alfalfa by a few farmers in our irrigated belt in order to overcome the danger of bloat in live stock when used for pasture.

Italian and English ryegrasses are grown to a considerable extent in western Washington for pasture purposes, but are of no value in any other part of the state. Tall oatgrass has been found to do fairly well in the lighter lands of western Washington, but it matures too early to make a good hay plant in that section because the rains are so frequent up to July that hay harvest is very uncertain.

Wisconsin.—Prof. A. L. Stone of the Department of Agronomy, Wisconsin College of Agriculture, Madison: There are only three or four grasses of real importance in Wisconsin. We have a large number of grasses, both cultivated and native, and many are valuable agriculturally. But for pastures and meadows there are but three or four which are in common use. We consider Kentucky bluegrass by far the best grass which we have for pasture. While it does not equal some other grasses, like brome or meadow fescue, for instance, in yields, it proves to be the best pasture grass for all conditions. In our best pasture we have a mixture of Kentucky bluegrass and white and alsike clovers, using but a very little however, of the alsike. On our lower soils we use some Kentucky bluegrass, a larger amount of redtop, white and alsike clovers. We find that the redtop gives better satisfaction on the low soil than the Kentucky bluegrass, though a mixture of the two gives very good satisfaction.

In the order of their merit, I should say that the four best grasses would be Kentucky bluegrass, redtop, brome grass and either

orchard grass or meadow fescue. For highlands, we would use a mixture of Kentucky bluegrass and white clover; for lowland Kentucky bluegrass, white and alsike clovers and redtop. For meadows we use timothy, either alone or a mixture of timothy and red clover for the higher ground, timothy and alsike clover for the lower ground.

In establishing bluegrass pastures, it is customary for our farmers to sow a mixture of timothy, redtop, Kentucky bluegrass, and white clover. This gives an opportunity to get at least two crops of hay from the timothy and clover, and by the time the timothy and clover are gone we get a fair sod of Kentucky bluegrass, and get a crop which may then be pastured. Ordinarily the mixture for this purpose would be about 15 pounds of timothy, 8 pounds of red clover, 10 pounds of Kentucky bluegrass and 2 pounds of white clover. This mixture for meadows would be changed somewhat in regard to the soil, using alsike clover and possibly redtop and Canada bluegrass in place of Kentucky bluegrass on low wet ground.

Since brome grass has become popular many of our farmers are mixing some of it and also more or less redtop in all pasture seeding. In this way they get grasses which are inclined to mature at different times of the year, and so obtain a continuous pasture.

Medium red clover is the most popular of any of the clovers grown in the state. Alfalfa where it does well is crowding out even the red clover. Thus far we have found very few sections of the state, however, where alfalfa has given very good satisfaction. The area devoted to this plant, however, is rapidly increasing, as we come to better understand the methods of handling it. Besides growing the alfalfa by itself, many of our farmers have adopted the plan of mixing in more or less alfalfa seed in their timothy and clover seedings, thus getting some alfalfa in all the hay grown on the farm. This not only adds to the palatability of the hay, but assists in establishing the bacteria in the soil. Next to these two alsike clover is perhaps next in popularity and importance. It grows especially well in Wisconsin, and is used to a very large extent as an addition to our meadow mixtures. Next in order would undoubtedly be the mammoth clover. All of these give fairly good satisfaction, though the mammoth clover is slightly too coarse for the best grade of forage.

Few farmers in Wisconsin have yet resorted to the use of commercial fertilizers. We have advocated the use of barnyard manure

and the rotation of crops to preserve the fertility of the soil, and discouraged the use of commercial fertilizers. The programme for the ordinary farmer is as follows: The whole pasture is given a good coating of barnyard manure usually with a manure spreader, thus dropping the manure evenly. This is plowed down and corn planted the next year. Corn is followed by one year of grain, either oats or barley, and the field is seeded to timothy, red clover, Kentucky bluegrass, white clover, in the proportions already mentioned. The next year hay is cut, depending on circumstances. The field is either left for hay the second year, or is turned into pasture. Ordinarily the farmer runs it two years to hay, and then one year to pasture, depending on the rotation of crops adopted. We have found that by this system we have been able to get very satisfactory crops of grain and hay. Nothing other than the application of barnyard manure and the change of crops has thus far been done to increase the yield of clover in this state.

Hawaii.—Prof. F. G. Krauss, in charge of Rice and Cotton Investigations, Hawaii Experiment Station, Honolulu: Bermuda is a valuable pasture grass, thriving throughout the Hawaiian group. It is very drouth-resistant, spreads rapidly, and is difficult to eradicate. It responds wonderfully to irrigation and tillage, is rarely fertilized; but results from cattle droppings in pastures suggest that manuring would pay well. It is rarely used as a soiling crop, but lawn mowings of this grass are commonly fed to family horses and cows with good results.

Para grass is extensively planted by dairymen throughout Hawaii, and is considered a nutritious feed for both cows and horses. Under irrigation it yields 4 crops in 12 months. The writer has made weighings from fertilized plots averaging 20 tons of green fodder per acre, per single cutting. The crop is planted from cuttings of the mature stems, which are long, close-jointed trailers. Furrows are plowed 18″ to 36″ apart and the cuttings a foot long set a few inches apart in the furrow, which is then partly filled in and then irrigated. Often yields are obtained when the plants are a year old. Fields require renewing, or at least plowing once in five years or so. It is principally used as a soiling crop and should not be permitted to get too old to avoid woodiness.

Water grass is a valuable Australian "bunch" grass gradually meeting with the recognition it deserves. Imported seed germinates

poorly. It makes great dense clumps of tender nutritious forage or fodder greedily eaten by all kinds of live stock. It responds well to irrigation and fertilization. The clumps may be divided and replanted, such renewal being advisable every three or five years. When well established in pastures it spreads through natural seed distribution.

Rhodes grass, a comparatively recently introduced grass, is meeting with high praise from all who have tried it. It is very drouth-resistant and yields a nutritious grass, which may be cured for hay. It pastures well or may be used for soiling. Horses, cattle and sheep relish and thrive on it. It spreads naturally from seed, or may be propagated by root division.

Buffalo grass is another valuable introduced pasture grass. It produces a rather dwarf growth, but a very dense matting not easily destroyed when once established. It is propagated by root or stem divisions as well as by seed.

Guinea grass is a dense, coarse, upright bunch grass, attaining a height of 4′ to 6′, relished by stock when young and tender, but becoming harsh with maturity it has more limited use than the other sorts mentioned. It is very hardy against adverse conditions, and finds favor on that account.

Many grasses especially suited for range pastures have been introduced into Hawaii during the past dozen years, but the writer is not familiar with their conditions. In a general way I have understood that the peas, bent grasses, bromes, gramas, festucas and rye grasses have become more or less established throughout the group.

Alfalfa is practically the only "clover" grown in Hawaii. It thrives luxuriantly under favorable conditions and yields 10 to 12 cuttings annually. Its culture is continually being extended and bids fair to become the leading fodder where conditions are favorable for its growth.

England.—James Peter, Estate Agent, Berkeley Castle, Berkeley: As to pasture management, for fertilizers nothing can beat basic slag for improving the herbage and giving a quick return. It is marvelous the result it has on our cold clay soils with a dressing of 5 and 6 cwts. to the acre. Farmyard manure well made is the most complete manure of all others, but any kind of dressing if only fresh earth, will do pasture land good. Ditch cleanings and

pond scrapings mixed with lime in a composite heap makes a fine dressing for pasture land. Ground bones of 4 cwt. to the acre is a dressing that should be applied to all grazing pasture land once in 7 years. All pastures should be well harrowed in the winter to remove the moss that grows in the bottom; the harrow helps to stimulate the grass roots.

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