EXPERIMENT STATION

OF THE

KANSAS STATE AGRICULTURAL COLLEGE,

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BOTANICAL DEPARTMENT.

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FORAGE PLANTS FOR KANSAS.

One of the important agricultural problems of Kansas, as of all farming regions, is the raising of forage. In the early days the native grasses of our plains furnished the necessary sustenance, but as the country has increased in population the methods have become more intensive. At present it is necessary to raise forage to supplement or even entirely replace the native grasses.

In considering the question of what forage plants should be grown in a certain locality, one must bear in mind all the conditions. It is best to have a variety. Our native pastures furnish such, and it is the natural requirement of herbivorous animals. The feeding value should be as high as possible; hence the use of legumes. The crops should be such as are adapted to the climatic conditions. In Kansas this necessitates the use of drought-resisting plants, as alfalfa and Kafir-corn. The soil conditions may exclude crops otherwise adapted. It must be borne in mind that judgment should be withheld concerning plants which are otherwise desirable but do not prove adapted to the climate. By proper selection, such plants may, in a few seasons, become acclimated. The cowpea, for instance, although a tropical plant, has by successive stages been carried north until it can be grown in Kansas and in other districts even farther north. Finally, plants should be chosen that will give a continuous supply of feed through the year without injuring the soil.

At the Experiment Station grass garden there have been grown a large number of forage plants, many of which have proved of no value, others were of doubtful or possible value, while a few gave promise of success. The last named are included in this bulletin. Besides these, a few others which as yet cannot be recommended are considered on account of the attention they have received in other parts of the country.

It will be observed that nearly all our forage plants that are not grasses belong to the legumes, the two principal exceptions being rape and Australian salt-bush. Alfalfa stands at the head of the list of forage plants in those localities where it can be successfully grown. But even there it is probably best to depend on this for dry feed and use other crops during the growing season. When there is no open range, pastures are necessary. In order not to wear out the permanent pastures, it is often advisable to supplement them with auxiliary feeds. Dairymen find it necessary to feed concentrates during the summer, when our pastures decrease in the supply of forage. By proper soiling of legumes or rape this expense can be much reduced. Rye furnishes an excellent green feed, both in the fall after the pastures have failed and in the spring before they have reached their best production.

LEGUMES.

The order *Leguminosæ* furnishes many valuable forage plants. The importance of the legumes in this respect depends upon the large amount of protein contained in the foliage and seeds. While most plants exhaust the soil of its nitrogen content just in proportion to the amount absorbed and converted into protein, legumes not only manufacture a large amount of protein, but enrich the soil in nitrogen at the same time. They are able to do this on account of the small tubercles or nodules which form upon their roots.

These nodules vary from the size of a pin-head to that of a buckshot. Certain micro-organisms inhabit these, and have the power to take the nitrogen from the air and convert it into a form which can be used by the plant upon which they grow. Consequently, the soil upon which legumes are growing is becoming richer instead of poorer in nitrogen. If all the plant is turned under, the soil gets the nitrogen returned to it. If the foliage or a part of it is used in the form of hay, as pasture, or for soiling, the soil still gets the benefit of what is in the roots. It is sometimes supposed that in turning under a green crop, such as rye or common weeds, the soil is enriched or fertilized. This is not the case, for nothing is returned to the soil in the way of minerals except what was previously absorbed from the soil. The addition of the green material may be of benefit in supply-

ing humus or otherwise altering the physical conditions, but no elements can be added except when the plants turned under are legumes. In that case, as we have shown, nitrogen will be added. Hence, there is always a double gain in raising legumes for fodder. Forage is obtained and the soil renovated at the same time. Every farmer should endeavor at least to rotate legumes with other crops in order to maintain the fertility of the land.

COWPEA.

COWPEA. *Vigna catjang.* An annual from southeastern Asia. It has been grown for many years in the Southern states, where it is a common and highly prized forage plant. There are numerous varieties, some bush form and some long and trailing vines, with all gradations between. The bush forms tend to become more vine-like if transferred southward, and the reverse. Although the cowpea has not been grown in Kansas to any great extent, yet recent trials seem to show that it can be successfully grown as a forage plant. Its chief use is for soiling purposes. It can be grown for hay but is difficult to cure, and other plants better adapted to that purpose can be grown in Kansas.

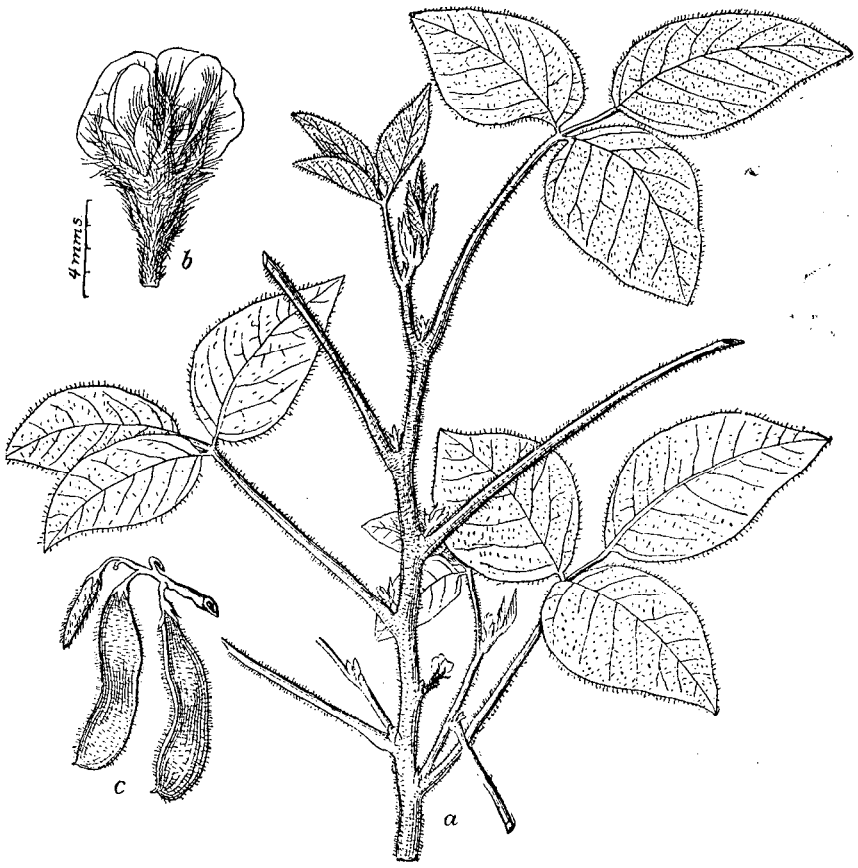
The cowpea can be sown broadcast, or better in drills, far enough apart to allow of cultivation when the plant is young. It should not be planted till the ground is well warmed, nor where the ground is too wet, as the seeds rot easily. The middle of May is probably soon enough for Kansas, and the planting can be delayed even until August. The vines can be mowed or pulled up and fed green. Its feeding value is equal to clover hay. If it is desired to cure the vines for hay, they should be gathered when the pods are beginning to turn yellow. A method recommended for curing is to stack the vines in a rack of poles so that the air can circulate freely. As previously remarked, cattle, sheep and horses should be fed the green vines, as it is more economical than when the stock is pastured upon them, and there is less danger of bloating.

Hogs can be pastured upon the vines with profit, especially after the peas have begun to form. There is occasional complaint that stock will not eat the cowpea. In our own experience we have had no such trouble, but, like all strange foods, stock may need to acquire the taste. The same difficulty is found with other plants, even alfalfa.

The only practicable method of harvesting the seed is to gather it by hand.

The nutritive ratio of the cowpea is so narrow that it is best not to feed it alone, but mixed with other roughage, such as sorghum, Kafir-corn, or corn-fodder; otherwise some of the protein may be wasted.

The cowpea is an excellent crop for orchards. It is a well-recognized method of orchard cultivation that the ground should be given rather deep cultivation early in the season, followed by more shallow cultivation till midsummer. It is an excellent practice to sow some kind of a cover crop at this time and allow it to remain over winter. The cowpea is, in our opinion, the best crop for this purpose. Being a legume, it acts as a soil renovator, as explained in the introduction to legumes. It has all the advantages as a cover crop, and will furnish much forage besides. What is not used for feed can be plowed



SOY BEAN.

under the following spring. One of us has tried this in his orchard with entire satisfaction. In the experimental plats the results were very promising.

SOY BEAN. *Glycine hispida.* This plant is so well known and has been so thoroughly tested in Kansas that we will not discuss its merits here, but refer the reader to Bulletin No. 92 of this Station, and also Bulletin No. 96, which discusses soi inoculation for soy beans, and Bulletin No. 100, which gives the experience of Kansas farmers in 1900 with this crop.

Three lots of Japanese seed were received through the United States department of agriculture (Nos. 4912, 4913, and 4914). These gave excellent results, and will compare favorably with the Early Yellow soy, which is the variety usually grown in this region. They all, however, require a much longer period for maturing their seed, and for this reason would not be adapted as a catch-crop, as is the Early

Yellow soy, which requires about ninety days to ripen its seed, while the first two numbers did not mature until 128 days after planting, and the last named (4914) required 166 days to mature its seed. No. 4914, while possibly not to be recommended as a forage crop on account of its lateness, gives promise of success as a late garden vegetable. The beans resemble the garden pea, and do not have the rank taste which is so noticeable in the other varieties of soy beans. It is a very prolific bearer, drought resistant, and seems to be unaffected by any save very severe frosts.

WHITE CLOVER. *Trifolium repens.* A low-growing perennial, spreading by creeping stems. Flowers white, the older ones more or less purplish tinged. A native of the cooler parts of North America and Europe. It is the shamrock of Ireland. It is of no value as a hay crop, but is quite useful in pastures through the eastern part of the state. It is a common practice to sow a mixture of White clover and blue-grass for this purpose, and also for lawns.

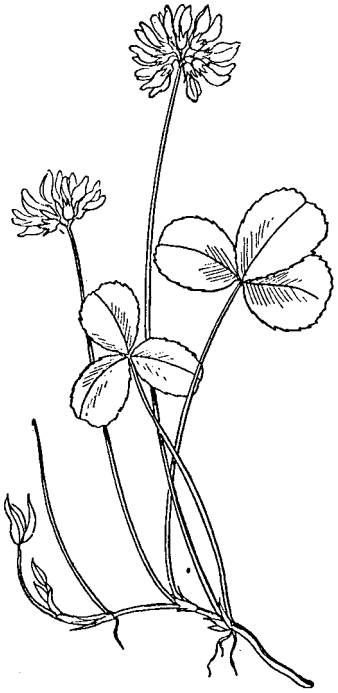
MAMMOTH CLOVER. *Trifolium medium.* Resembling Red clover, but usually producing a ranker growth and differs in having no spots upon the leaves. It is adapted to more moist land than Red clover.

RED CLOVER. *Trifolium pratense.* This is a short-lived perennial, or often scarcely more than a biennial. A native of Europe. It is commonly grown through eastern Kansas, but as far west as Manhattan it is uncertain. It is a common practice to sow timothy and clover together, the former tending to hold the clover upright, Since it is so short-lived, care must be taken to allow a crop to go to seed each year in order that the field may be reseeded, if the growth of the clover is to be maintained.

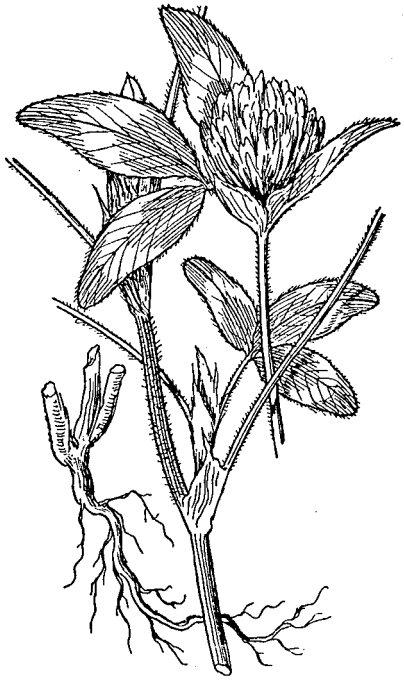
ALSIKE CLOVER; SWEDISH CLOVER. *Trifolium hybridum.* A perennial European clover, suggesting a hybrid between Red and White clover, and hence sometimes called Hybrid clover, but it is not a hybrid. It will thrive on soil too wet for Red clover, but on moderately dry soil it is probably not to be so highly recommended as that species. It should not be sown alone, as better results are obtained by mixing it with tame grasses.

BUFFALO CLOVER. *Trifolium reflexum.* A tufted biennial clover, native of southeastern Kansas and eastward. The rose-colored flowers are borne in large heads. This undoubtedly would prove a valuable clover for eastern Kansas, where a short-lived plant is desired.

CRIMSON CLOVER. *Trifolium incarnatum.* An annual, native of the Mediterranean region. Grows erect, a foot or two high, and bears elongated heads of scarlet flowers. It is much used in the South as a soiling crop. It is susceptible to drought and excessive cold. It

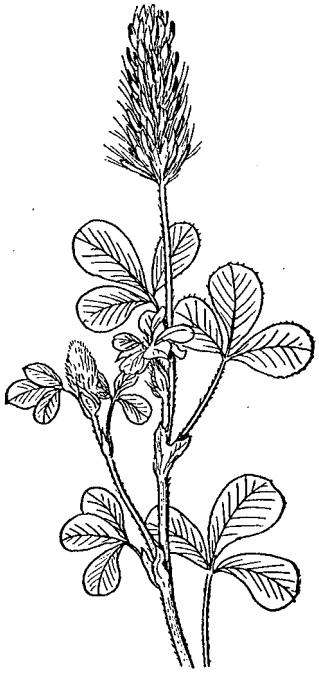


WHITE CLOVER.



RED CLOVER.

ALSIKE CLOVER.



CRIMSON CLOVER

will probably do well in southeastern Kansas, but in other parts of the state should be tried with caution.

EGYPTIAN CLOVER. *Trifolium alexandrinum.* An annual clover from Egypt, which is recommended for the Southern states. This made a fair growth in our experimental plat, but we would not recommend it for Kansas until given further trial.

BOKHARA CLOVER; SWEET CLOVER. *Melilotus alba.* A biennial, growing to the height of several feet. A native of Europe, where it has been grown somewhat as a forage plant. The leaves are divided into three leaflets. The branches have slender clusters of small white flowers at the apex. It is not, strictly speaking, a clover, but is a legume, closely allied to that group and to alfalfa. It is a common roadside weed in eastern Kansas. The seeds germinate in the fall, and produce considerable growth the same season. The next spring the growth is resumed and the plant matures in early summer. Opinions differ as to its value as a forage plant. It has a bitter taste, for which reason it is not relished by stock unless they acquire a taste for it. It is said that if stock are turned into a field in early spring they will learn to eat it. It is well worth extended trial in Kansas, for it is a hardy and vigorous plant yielding large quantities of forage. Like other legumes it enriches the soil upon which it grows, and in addition is a valuable honey plant. It can be sown in drills in early spring or in early fall. The ground should be prepared as for clover or alfalfa. By cutting before seed is produced the vegetating period can be extended and two or more crops secured.

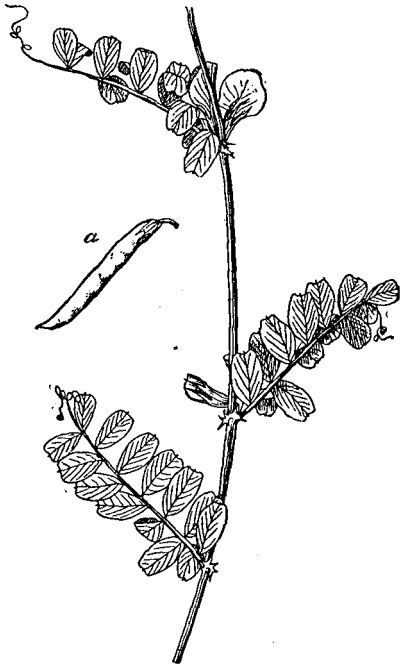
ALFALFA; LUCERN. *Medicago sativa.* This important forage plant is discussed in Bulletins Nos. 85 and 90 of this Station, now out of print. It can without doubt be grown in all parts of Kansas where the subsoil is sufficiently porous and where standing water is not too close to the surface. It is of most value as a hay plant, although it can be used for pasture and soiling purposes. It seems better, however, to supplement alfalfa with some of the other pasture or soiling crops during the growing season.

SAND VETCH; HAIRY VETCH. *Vicia villosa.* A perennial or at least a biennial vetch from western Asia. This plant has given much promise in various parts of the United States, and our trials show it to be adapted to Kansas fairly well. The seed should be sown in drills with some kind of grain, the latter to act as a support and keep the vetch in a more upright position. Our trials have been with spring-sown seed. It is recommended to sow in fall (August to middle of September) for winter and spring forage. It has survived the winter here and is well worthy of trial. We would recommend

EGYPTIAN CLOVER.

WHITE LUPINE.

DAKOTA VETCH.



SPRING VETCH

that it be sown with rye. This, if successful, will give excellent feed at a time when there is usually a shortage.

Our spring-sown seed sown alone gave a dense mass of excellent succulent forage about a foot high.

SPRING VETCH; TARES. *Vicia sativa.* The results with this were so unsatisfactory that we cannot recommend it.

DAKOTA VETCH. *Lotus americanus.* This is a native annual of Kansas and other states to the north and west. It is a valuable forage plant of the ranges; it is recommended for cultivation by the United States department of agriculture (Circular No. 6, Division of Agrostology). In some parts of Kansas it grows in vast quantities, and the seed could be easily gathered and a start made in its cultivation. It is bushy branched, about a foot high, with small, yellowish flowers, and slender pods about an inch long. The leaves are mostly divided into three leaflets, In Kansas it is found in the central counties, from Republic and Smith to Sumner and Comanche, and also in the eastern tier of counties from Wyandotte south.

BIRD'S-FOOT TREFOIL. *Lotus corniculatus.* A low perennial with yellow flowers. Allied to the clover, but has five leaflets. It withstands drought well, and, though not yielding a large amount of forage, seems to give considerable promise as one of the constituents of a mixture for sterile pastures.

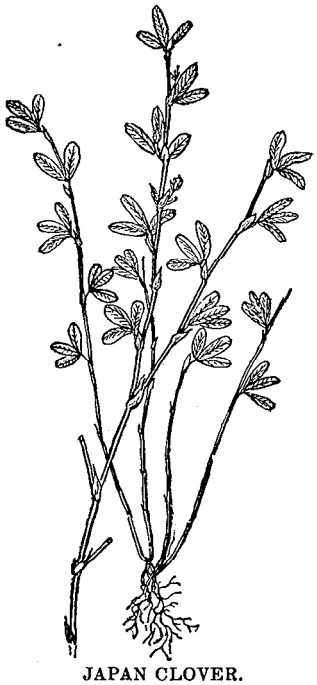
WHITE LUPINE, *Lupinus albus.* BLUE LUPINE, *Lupinus hirsutus.* YELLOW LUPINE, *Lupinus luteus.* The lupines are all annual, and, although used in Europe as forage or for enriching the land, give little promise for Kansas.

FLAT PEA. *Lathyrus sylvestris wagneri.* A deep-rooting perennial from Russia, resembling the sweet-pea. In our experimental plats it was slow to start, but finally produced a fair growth. This plant is reported to have given good results in many of the Southern states, and is especially recommended for arid regions. It is difficult to start, but when well established gives excellent forage for an indefinite period. It does well on about the same kind of soil as does alfalfa. In spite of its good qualities, it is doubtful if it can compete with alfalfa.

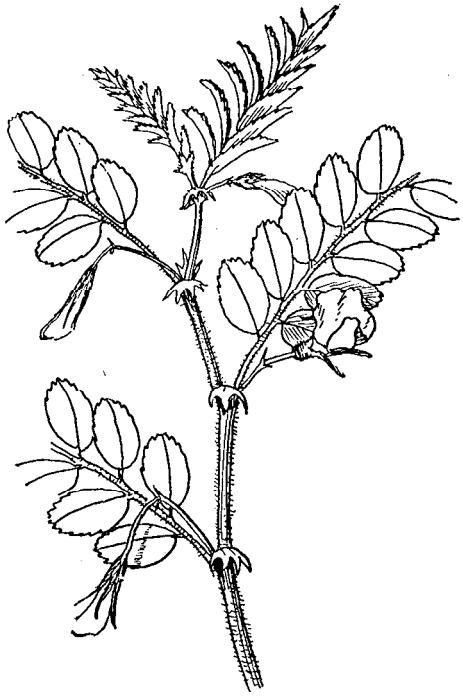
JAPAN CLOVER. *Lespedeza striata. A* prostrate annual from China, much used and highly esteemed in the Southern states, where it is grown particularly on barren or exhausted soils. In rich soil it grows upright to the height of two feet, and can be mown for hay. On more sterile soil it mats together into a turf, and produces good pasture.

We would recommend the plant for trial on sterile hills of south-

FLAT PEA.

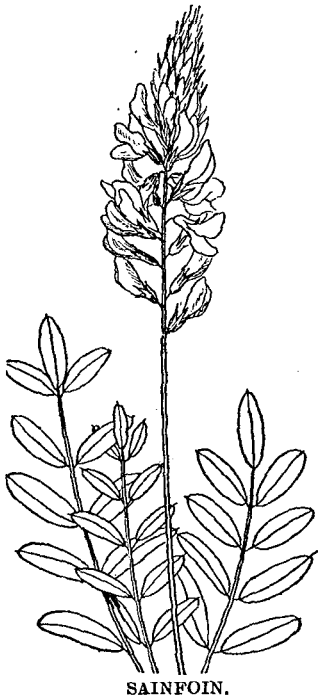


JAPAN CLOVER.



GRAM OR CHICK PEA.

BEGGAR WEED.



SAINFOIN.

eastern Kansas. It does not give forage until about June, and does better on clay than on sandy soil. It can be sown in spring or in fall with rye.

SERADELLA. *Ornithopus sativus.* We have tried this annual, but it does not seem to be promising.

SAINFOIN; ESPARCETTE. *Onobrychis sativa.* A deep-rooting perennial which has quite a reputation in Europe, and is recommended for barren soil. It has given good results in the eastern part of this country. We made four plantings of seeds from different sources in our experimental plats, but none came up. We are therefore unable to state its value for Kansas.

GRAM; CHICK PEA; GARBANZO. *Cicer arietinum.* A native of America. Annual. Cultivated in parts of the the old world for the seed, which is used as food for cattle and also for human food. Seeds sent from the United States department of agriculture were tested in our experimental plats. The plants grew well, and produced an abundance of seed.

On account of the large quantity of oxalic acid contained in the foliage the plant is not grown for forage.

BEGGAR WEED. *Desmodium tortuosum.* An erect annual from the West Indies, now much grown in Florida and other Southern

states for hay and as a soil renovator. This would be worth trying on the sandy soil of our southern counties. In our plats it attained a height of about six feet. In Florida it may grow as much as ten feet in height.

SCOTCH BROOM. *Cytisus scoparius.* A native of northwestern Europe and the British Isles. It is a perennial legume, more or less shrubby if the tops do not winter-kill. The numerous slender, green stems, which are nearly bare of leaves, are used more or less in Europe as winter food for sheep. It thrives on stony or sterile soil and may be of use in some parts of Kansas. It also goes by the names *Genista scoparia*, *Sarothamnus scoparius*, and *Spartium scoparium.* Plants in the experimental plat made a growth of about twenty inches the first year.

GORSE; WHIN; FURZE. *Ulex europœus.* A prickly shrub, native of Great Britain and adjacent parts of Europe, where it is much used for forage during the winter months. Grows on rocky hills and other situations unfavorable for the cultivation of crops. Plants in experimental plats made a growth of twelve inches the first year. This may be of value as an auxiliary plant upon the stony hills of many parts of Kansas.

VELVET BEAN. *Mucuna utilis.* An annual vine, native of India, which has been grown in the Southern states with great success. It is an excellent forage plant, but so far as we know has no advantage over the cowpea in Kansas. Whether it can be successfully grown here has not been sufficiently tested. In our experimental plats it produced a dense succulent growth of vines, though it did not flower. Seed should not be sown till the season is well advanced, usually about the first of June.

GREEN GRAM. *Phaseolus mungo.* A climbing vine from Russia. Our plants were from seed sent out from the United States department of agriculture. Our plats of this plant gave good results and the plant is worthy of further trial. It would be used in the same way as cowpea and velvet bean.

GRASSES.

TIMOTHY. *Phleum pratense.* Of the history of this standard grass, Mr. Vasey gives the following in his descriptive catalogue:

"This grass, as known in cultivation, is supposed to have been introduced from Europe, but it appears to be indigenous in the mountain regions of New England, New York, and the Rocky mountains. It is said that about the year 1711 a Mr. Herd found this grass in a swamp in New Hampshire, and cultivated it. From him it took the name of Herd's grass. About the year 1720 it was brought to Maryland by Timothy Hanson and received the name of 'Timothy grass.' It now the favorite and prevailing meadow grass over a large part of the country. Henderson states that it is supposed to have been introduced into England from Virginia about 1760."

Timothy succeeds well in the eastern counties of Kansas, where it is commonly sown with clover. As far west as Manhattan, however, it is uncertain. Yet occasional fields of timothy in good condition are reported from still farther west. The grass grown alone is not suited to grazing, as close cropping destroys the little bulblets at the base of the stem, from which the succeeding crop springs.

Timothy is not as nutritious hay as some other kinds; in fact, it is the least nutritious of those commonly grown. The tables show that 100 pounds of timothy hay contain 2.8 pounds of digestible protein, while a like amount of orchard-grass contains 4.9, Meadow fescue 4.2; and the legumes a much higher per cent.: Red clover hay 6.8 and alfalfa hay 11.0 pounds of this valuable ingredient. For this reason we would recommend that orchard-grass and Meadow fescue be grown, rather than timothy, over the eastern third of the state.

ORCHARD-GRASS. *Dactylis glomerata.* For eastern Kansas this is one of our best pasture and meadow grasses. Professor Cottrell, in Press Bulletin No. 62 from this Station, says of this and Meadow fescue (English blue-grass):

The College farm is 108 miles west of Kansas City and is all upland. Tame grasses have been grown here since 1873; nearly all known kinds have been tested, and many kinds have been tried repeatedly. Of all the hundreds of kinds tested we can recommend but two grasses for field seeding—orchard-grass and English blue-grass, and but one other for trial on a small scale—*Bromus inermis*. While many others have made satisfactory growth for one to three years, all varieties tested except the ones mentioned have finally totally failed. Timothy does well in a wet year, but in a dry year every plant in a field dies. Tall meadow oat-grass will sometimes give a profitable yield for two or three years, and then die from drought. Kentucky blue-grass lives for years, but supplies feed only in wet weather. Johnson grass furnishes no pasture until June, gives a moderate yield of coarse hay, and in a severe winter is entirely destroyed.

Orchard-grass has been grown on the Kansas Agricultural College farm in large fields since 1875 and has successfully withstood all drought, floods, heat and cold since that date, except during the winter of 1885-'86, when all orchard-grass on the College farm but that in one field was killed by the severe cold. The orchard-grass not killed was seeded in 1885. This has been pastured or

TIMOTHY. KENTUCKY BLUE-GRASS. ORCHARD-GRASS.

mowed each year since, and is apparently in as good condition to-day as at any time in its growth. This record shows but one season in twenty-five years in which orchard-grass has been seriously injured.

English blue-grass has been grown in fields on the College farm since 1879, and has withstood all extremes of climate except in the fateful winter of 1885–'86, when all seedings of this grass were killed. It suffers more than orchard-grass from drought, but is not so coarse, and many farmers are using English blue-grass and clover for hay on account of its fine quality.

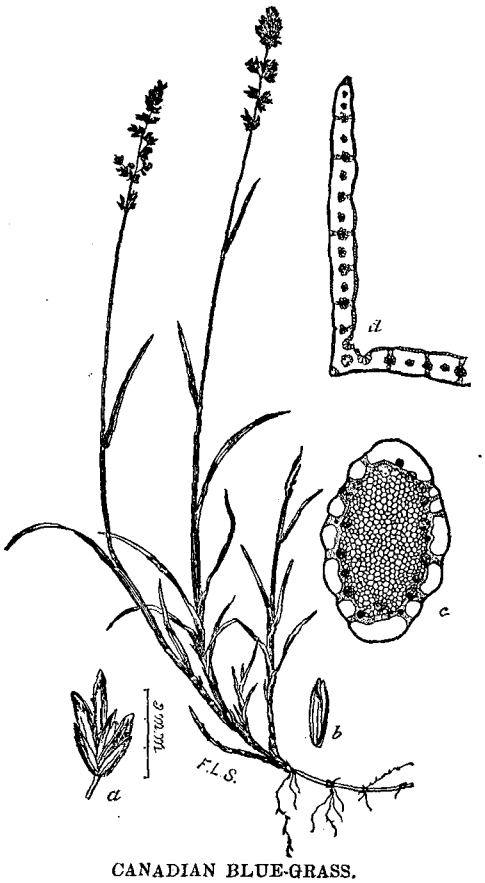
For pasture and for hay, where alfalfa is not wanted, we sow, per acre, orchard-grass twenty pounds, English blue-grass fifteen pounds, and, if the season is favorable, Red clover two to three pounds. We seed with a press-wheel drill, about the middle of April, on thoroughly prepared ground that has been allowed to settle after plowing. Seed without any other crop and mow the weeds the first summer. Pasture from this seeding stands drought and heavy pasturing well, furnishes early and late feed, and good pasture in midsummer unless drought is severe, when it dries up, to start again vigorously when rain comes.

Grass from this seeding is ready to cut early in June, in favorable seasons will give a second cutting, and in all seasons may be safely pastured after the first crop of hay has been removed. Orchard-grass cut in blossom makes fairly good hay; cut when ripe the hay has about the same feeding value as rye straw.

A native of Europe. When grown alone it tends to form bunches with bare spaces between. For this reason it is best to mix it with other grasses, which fill in the bare spaces between the orchard-grass and form a more compact sod. As shown above, Meadow fescue is the best grass for this combination in Kansas.

MEADOW FESCUE. *Festuca pratensis.* Many of the fescue grasses are grown in various parts of the country, but none of them seem to be adapted to Kansas conditions except the above. It is a native of Europe. A taller form goes under the name of Tall fescue (*F. elatior*). In Kansas, Meadow fescue frequently goes under the name of English blue-grass, but it is not a blue-grass, and should not be called by that name. It is recommended that this be sown with orchard-grass, to which the reader is referred for methods of culture.

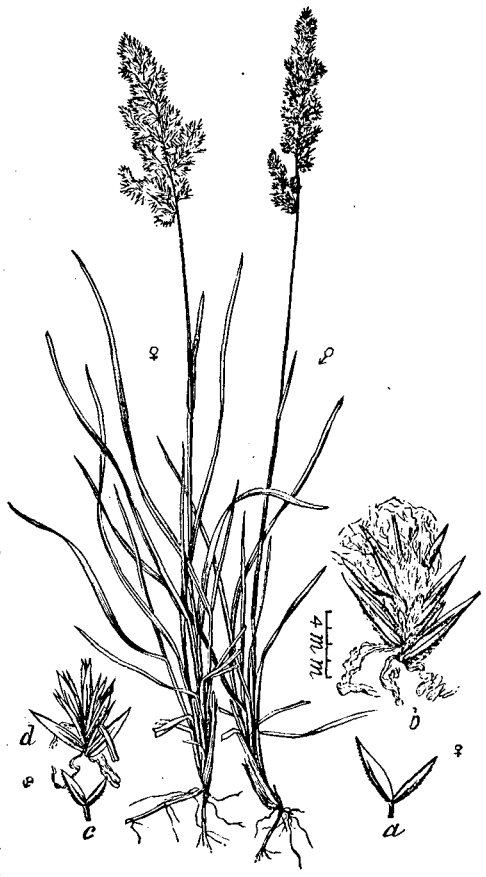
KENTUCKY BLUE-GRASS. *Poa pratensis.* This is the common blue-grass of Kansas. It is widely used as a lawn grass, and in the eastern counties not infrequently forms a part of permanent pastures. It is a perennial, spreading by underground stems and forming a compact sod. The flowering stems are a foot or two high, or even taller in moist situations, and bear at the top a spreading pyramidal flower cluster. For lawns, it is recommended to sow three bushels of seed per acre, and roll in rather than cover the seed. This grass is called June grass in the Northern states, green grass in Pennsylvania, and Smooth-stalked meadow grass in England. It is a native of the northern regions in both hemispheres, but it is not a native of Kansas.



CANADIAN BLUE-GRASS.
a, Spikelet; *b*, Floret;
c, Magnified view of cross-section of flattened stem;
d, Magnified cross-section of a leaf blade.

Blue-grass gives pasture early in the spring and late in the fall, but during the summer months it dries up. It also tends to drive out other grasses and form a sod of its own under trees and in open timber where the underbrush has been cleared. It is a valuable grass, but too much must not be expected of it. Just how far west in the state it can be utilized we are unable to state, but there is considerable in the pastures about Manhattan.

CANADIAN BLUE-GRASS. *Poa compressa.* This resembles the preceding but is much less valuable. It differs in having a blue-green color, strongly flattened or two-edged stems, and a small, narrow flower cluster. Under similar conditions the growth is not so tall. Like common blue-grass, it spreads by creeping stems and forms a strong sod. It will grow on thinner, poorer soil than the preceding. It is what goes under the name of "blue-grass" in the New England and Middle states. Although of considerable value in the East, especially on poor soil, it seems not worthy of recommendation for Kansas. It is offered for sale in some catalogues under the name of English blue-grass, but is not to be confused with the grass known in Kansas by that name.

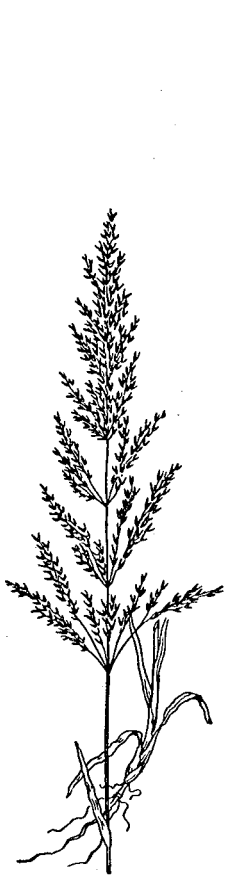


TEXAS BLUE-GRASS.

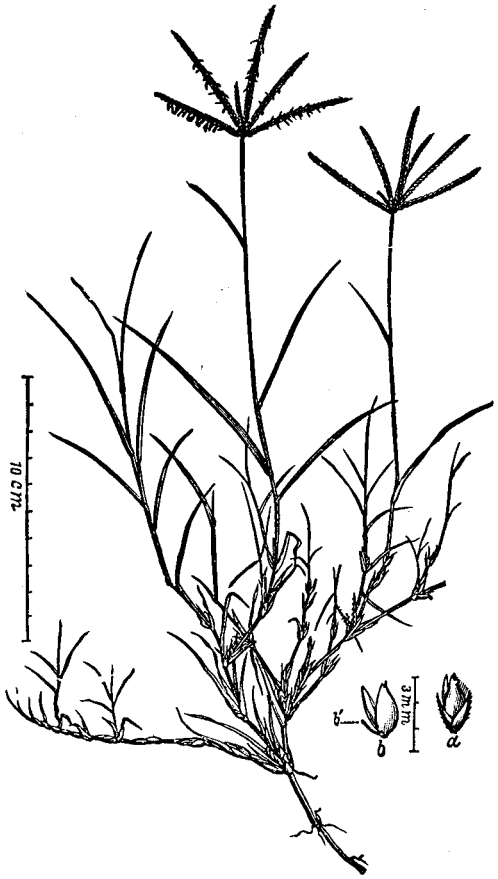
TEXAS BLUE-GRASS. *Poa arachnifera.* A perennial, spreading by creeping underground stems, forming a strong growth one to three feet high. It is a native of Texas, but is cultivated through the South quite extensively. It is highly recommended for permanent pasture, especially during the winter months. It may do well in some parts of southern Kansas, but has not been sufficiently tested. The flower cluster at the top of the stem is dense and narrow, not spreading like Kentucky blue-grass.

REDTOP. *Agrostis vulgaris.* This grass is commonly grown in the Eastern states, and does well in the eastern counties of Kansas. It will not stand drought, but in wet meadows it thrives and produces a good growth. A native of northern Europe and northern United States.

TALL OAT-GRASS. *Arrenatherum avenaceum.* A constituent of pastures in the East. Our plat of this grass gave a promising growth.



REDTOP.



BERMUDA GRASS.

It may be recommended for the eastern counties as a constituent for perennial pastures. A native of Europe.

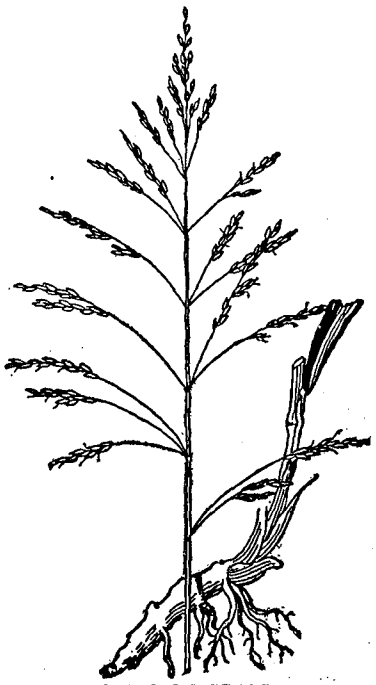
BERMUDA GRASS. *Cynodon dactylon.* A native of tropical regions and introduced in the South, where it has become spontaneous and common. It is an excellent grass for sandy soil and furnishes a nutritious forage. It is a low, spreading or creeping grass, and cannot be used for hay, nor is the amount of forage large, but it can often be utilized on sandy land where other good grasses will not grow. But it is easily killed by cold winters, and hence is not likely to be of much value in Kansas except in the southern counties. Unless it will survive the winter it will hardly pay to raise it, as there are more valuable annual crops. Mr. Rohrer, of Dillon, Dickinson county, Kansas, writes that Bermuda grass survived the winter on his place and gives promise of being a valuable grass. He also states that

several of his neighbors obtained the seed upon the market and gave the grass a trial, but in no case did any survive the winter. Mr. Rohrer sowed a package of Texas blue-grass seed and his Bermuda grass seems to have come from this as an impurity, and is an especially resistant strain.

GOOSE GRASS. *Eleusine indica.* A tropical annual grass, common in the Southern states and extending into southeastern Kansas. A prostrate or spreading grass, found around habitations, along streets, and in similar situations. It is considered a weed, but the foliage is nutritious and relished by stock, for which reason it is mentioned here.

JOHNSON GRASS. *Andropogon halapensis.* This grass is a native of the Mediterranean region. It was introduced into the Southern states about 1830, and for some time was known by the name of Mean's grass, which name it still retains in some localities. About ten years later it was introduced into Alabama from South Carolina by William Johnson, and has since been quite generally known as Johnson grass. Its botanical name is *Andropogon halapensis*, or *Sorghum halapense.* It is sometimes called Guinea grass, but this name properly belongs to *Panicum maximum*, a tropical forage grass sometimes cultivated in southern Florida.

GOOSE GRASS.



JOHNSON GRASS.

Johnson grass has received considerable attention in Kansas lately. It has been grown in the plats of the Kansas Experiment Station for several seasons, and its behavior in our climate tested. It is a rank-growing perennial, with numerous strong, rather fleshy creeping rootstocks, by which it propagates. The stems and leaves are coarse, but quite succulent. It seeds abundantly, and seed can be purchased at all seed houses. If the seed is clean, about one bushel per acre is sufficient for sowing. Johnson grass is chiefly used for hay, for which purpose it should be cut early, before the stems become too old and hard. Usually two or three cuttings can be made. The seed should not be sown until the ground is warm or it will not germinate well. Johnson grass prefers rich, moist soil, though it will grow in quite a variety of soils. It is injured by severe winters, but the cold winter of 1898–'99 did not entirely kill out that in the experimental plat, and it quickly recovered from the effects of the cold. It is not a success as a pasture grass, as it is injured by grazing to such an extent that a pasture soon becomes useless, yet the vitality of the rootstocks is such that it is never entirely killed out in this way, and after a rest soon recovers from the effects.

Throughout the South, under proper conditions, it is considered an excellent hay grass, and in all parts of Kansas where there is sufficient moisture it will undoubtedly be valuable for the same purpose.

However, it is exceedingly difficult to eradicate the grass on land where it has obtained a foothold, and for this reason it may become a pestiferous weed. Hogs are rather fond of the rootstocks and when confined upon a plat of the grass will destroy it. But on soil adapted to its growth it requires great care to eradicate it. If one wishes to grow Johnson grass, the best plan is to devote a field to the purpose without expecting to subsequently put the field in cultivation. With care it can be confined to this field. After a few years the ground becomes so full of rootstocks that the development is hindered. To rejuvenate a field, it should be plowed and harrowed in the spring, or else thoroughly disked.

All these points should be carefully considered before the grass is given a trial. As a forage grass it may prove of great value, and the fact that it is difficult to eradicate may be in its favor in those parts of Kansas where it is not easy to grow forage plants successfully. But if tried, great care should be taken to keep it under control.

AWNLESS BROME-GRASS. *Bromus inermis.* Awnless brome-grass, or Hungarian brome-grass is a native of the dry, sandy regions of Europe and western Asia. It is a perennial, about the size and somewhat the general appearance of Meadow fescue or English blue-grass. It spreads by creeping, underground stems or rootstocks. It has been

tested by many of the experiment stations, from Canada and North Carolina to Mississippi and California. All recommend it highly for dry, sterile, light or sandy soil. It does not succeed well on wet land, but is one of the best grasses for resisting drought. Its chief value is for permanent pasture, though at many of the stations it has yielded a good crop of hay. In the South it is sown in the fall for winter pasture, but in the North it is sown in the spring. This Experiment Station now has in progress an experiment testing the relative merits of spring and fall sowing at Manhattan. At present we are unable to state positively the value of brome-grass for pasture in eastern Kansas, but from the experience in surrounding states we can recommend it for trial. The Garden City grass station reported very favorably upon it when tried there a few years ago. At a future time we will give the results of our trials and we should be pleased to have our correspondents inform us as to the results of their own trials.

AWNLESS BROME-GRASS.

Much of the seed upon the market at present is imported from Europe, but has not proven as satisfactory as that grown in this country, on account of its low vitality. With good seed, and soil not foul with noxious weed seeds, the amount sufficient to sow an acre is fifteen to twenty pounds. It frequently happens that an apparently poor stand allows the weeds to flourish the first year, but that nevertheless the second year's growth is favorable. For this reason judgment should not be passed upon the success of the trial until the second season. Ordinarily it is not best to pasture the grass the first season. A weedy field should be mowed in the summer.

Professor Cottrell writes of this grass as follows, in Press Bulletin No. 63:

This grass has been grown on the College farm on small areas since 1891. It has withstood the severest drought and cold we have had during these nine years without injury. It dries up during drought, but starts growing again rapidly as soon as rains come. We have grown it on upland only, and on this land it quickly forms a thick sod. It is one of our earliest grasses to start in the spring and stays green late in the fall, and will furnish pasture from two to four weeks longer in a season than will prairie-grass in this section of the state. We have not had a sufficient area to test its ability to stand heavy pasturing and trampling, but judging from the character of the sod formed by this grass, it will stand as hard treatment in this respect as any tame grass tried. It yields about the same amount of hay as orchard-grass or timothy. The hay is of second quality, not better than orchard-grass hay, and is not particularly relished by farm animals.

We have not made trials of this grass in large fields nor advised farmers to try it, because until this year the only seed that would grow came from the department of agriculture, and could only be obtained in small quantities. From 95 to 100 per cent. of the *Bromus inermis* seed purchased of seedsmen failed to germinate. It was chiefly imported seed. This year seedsmen guarantee their seed of this grass to have good vitality and we expect to sow it in large fields, and advise farmers to try it on a small scale.

From our study of it, *Bromus inermis* seems to be the only tame grass so far tested that will grow in the western half of the state, and judging from its habits here it will probably thrive there when a stand is secured. It also promises to be a grass that will grow well on upland pastures in eastern Kansas where the prairie-grass has been killed.

Like most tough, hardy grasses, *Bromus inermis* is not of the best quality. Judging from our trials of it, no farmer will want it for hay, except for horses, who can raise alfalfa. As a pasture, we expect it to be found inferior in quality to our buffalo-grasses or to the bluestem of eastern Kansas, but it can be grown on land where these valuable wild grasses have been killed and will furnish the best substitute for them that we have yet found. Its early and late growing qualities give it one advantage over the wild grasses.

We would advise sowing from twenty-five to thirty pounds of seed per acre, sowing in this section of Kansas about the middle of April and in the southern part of the state a little earlier. The ground should be free from weeds, thoroughly pulverized, and well settled after plowing before the seeding is done. If the soil is inclined to be dry, we would advise packing with some implement like the Campbell subsurface packer. In dry seasons we have secured good stands where the packer was used, with total failures where it was not used, all other conditions being the same. We would put the seed in with a drill having press wheels.

These opinions of *Bromus inermis* are formed from an experience on small areas. After growing this grass on large fields we may think differently of it.

As the seed is high-priced and the grass a new one, we would not advise a first trial of more than five acres.

MILLETS. This term is applied to several different plants. The following, taken from Press Bulletin No. 69, will distinguish between the common kinds. The Foxtail millets are the only ones grown in Kansas at all commonly. We have tried several kinds of Broom-corn

MILLETS.
1, Common; 2, Early Harvest; 3, German; 4, Golden Wonder; 5, Hungarian; 6, Japanese Foxtail.

millet in our experimental plats, but so far we are unable to recommend them with any degree of assurance.

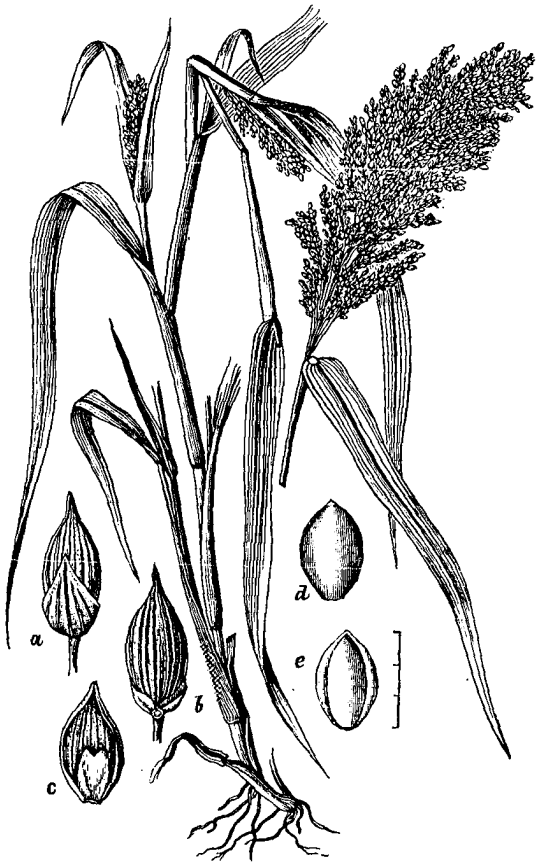
FOXTAIL MILLETS. To this group belong what is generally sold as "Common millet" and also a number of other varieties, all belonging to the species known to botanists as *Setaria italica,* and which is considered by many to have been originally derived from the common weedy, green foxtail *(Setaria viridis).* The seed is borne in a compact cylindrical, often more or less nodding cluster at the top or the stalk. The seed can be distinguished by the numerous minute transverse wrinkles. There are four groups of varieties. (1) Common millet, which is more resistant to drought. (2) German millet, also called Golden millet and Bengal grass, the commonest variety in the South; the latest of the Foxtail millets and coarser in foliage. Some of the so-called Japanese millets belong here. (3) Golden Wonder millet, which under favorable conditions gives the largest yield of seed, but does not endure drought. (4) Hungarian millet or grass, more commonly cultivated in the Northwest. This has the disadvantage of volunteering or persisting in the soil. The "New Siberian millet" is related to Hungarian grass, but may be a distinct variety. There are a number of different varieties of each of the groups mentioned.

BARN-YARD MILLETS. These have been long grown in the old world both for forage and food for man, but have only recently received much notice in this country. They received their name from the fact that they are derived from the common and well-known barn-yard grass, a weed in cultivated soil. They are characterized by having the flowers in branching clusters like the barn-yard grass *(Panicum crus-galli),* and the seed smooth and about twice as long as the Foxtail millets. Barn-yard millet gives promise of making a successful forage grass in this county. Closely allied to this are the Shama millet *(Panicum colonum)* and Sanwa millet *(Panicum frumentaceum),* both grown in India and other parts of Asia for the seed, which is used as food by the poorer classes. They do not give promise of success in this country.

BROOM-CORN MILLETS. These are derived from *Panicum milaceum.* This species has been cultivated for centuries in Europe, where it is the "Common millet." It is not extensively grown in the United States, but is offered in the trade under the name of Broom-corn millet and Hog millet. The seeds are borne in loose, drooping clusters, the branches of the cluster being long and slender, somewhat resembling the seed cluster of broom-corn, whence the name. The seeds are from white to yellow and dark red, and, like the preceding

sorts, are flat on one side and convex on the other, and resemble the Barnyard millet in size and absence of wrinkles.

PEARL MILLET. *Pennisetum spicatum* or *P. typhoideum.* Extensively cultivated in Africa for the seed, which is used for food, and occasionally in the southern United States, where it is used for fodder. Plants tall and stout, the seeds borne in a dense cylindrical cluster, but without the bristles characteristic of the Foxtail millets.

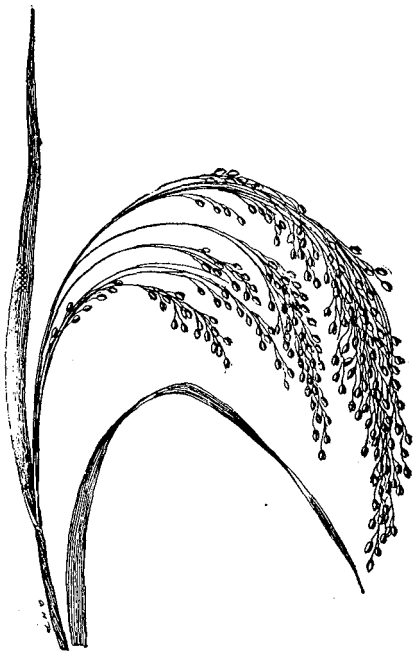


BROOM-CORN MILLET.
a, *b*, *c*, Spikelets and chaff; *d*, e, Seeds.

INDIAN MILLET. *Sorghum vulgare.* Certain varieties of sorghum or cane are very extensively grown in Africa and Asia for the seed, which is used for food. They also go under the name of Chinese millet, Black millet, African millet, Guinea corn, etc. At present these varieties of sorghum are not grown in the United States on a commercial scale.

TEOSINTE. *Euchlæna luxurians.* A native of Mexico, and thought by many botanists to be the original of our Indian corn. It is an annual plant, resembling corn or sorghum in general appearance, but, instead of producing an ear, there are in the leaf-axils several slender jointed spikes which are separate from each other instead of being united into an ear. However, in the United States the plant seldom flowers, and never produces seed except in south Florida or near the Gulf coast. It is cultivated in the Southern states, where it is considered a valuable forage plant, and under favorable conditions produces an immense amount of forage. For example, it is reported to have produced in Louisiana over fifty tons of green forage per acre.

TEOSINTE.



JAPANESE BROOM-CORN MILLET.

It requires a long growing season and considerable moisture, for which reason it is not well suited to Kansas conditions. It gives a fair amount of fodder here, but there is nothing to recommend it above corn, sorghum or Kafir-corn for the same purpose.

SORGHUM. *Andropogon sorghum,* or *Sorghum vulgare.* There are many varieties of this species grown for different purposes: some for the sweet juice, called saccharine sorghums; the non-saccharine sorts for fodder or the seed, as Kafir-corn, milo maize, Egyptian or Jerusalem corn, etc.; the broom-corns for the tough infloresence; a large group called Indian millets in Asia, for the seed.

Kafir-corn has been well discussed in Bulletin No. 93 of this Station.

Our fodder sorghums belong to the saccharine group, and are frequently called ``cane" in Kansas, but should not be confused with the sugar-cane of the South, which is quite a different plant. The varieties most commonly used in Kansas are the Amber canes and the Orange canes. Amber cane is the earlier. Some people prefer one kind and some the other. For fodder, it is usually sown thickly, either broadcast or with a drill. After cutting it is allowed to partially dry and is then piled in bunches or cocks, where it remains for some time. Many allow it to remain in the field until it is wanted for feed. In most parts of Kansas the weather is dry at that season and the sorghum cures without further protection.

Sorghum resists drought better than does corn, and, on account of its excellence as a stock feed, has come into high favor. It produces a large amount of forage, and on the whole is one of the best fodder plants of its class that we have. Its nutritive ratio is wide--that is, it is comparatively poor in protein—for which reason it should be combined with other more nitrogenous foods. It is also one of the most certain of our annual forage plants. It is a deep feeder, and is rather more exhausting to land than is corn. It does best in a rich, sandy loam, but gives a better return on thin land than corn. It would be an excellent plan to try sowing cowpeas with sorghum. The resulting forage would be a more nearly balanced ration. This, however, would probably necessitate sowing the sorghum later, as cowpeas will not germinate until the soil is well warmed.

CORN. *Zea mays.* Little need be said concerning this plant. Wherever it is grown it is used more or less as a fodder plant. Throughout Kansas it is usually cut up and shocked about the time the leaves begin to turn brown. The seed is not quite ripe, but it matures in the shock. If hot winds or a protracted drought threaten the crop it is cut and shocked to save it. The corn is husked out and the remainder is known as corn-fodder. Even when the corn is husked in the field, the stalks and leaves are utilized by turning stock upon them during the winter. Frequently corn is sown broadcast or drilled thickly when fodder alone is desired. It is then treated the same as sorghum or Kafir-corn. It is generally considered to be inferior to sorghum for this purpose.

RYE. *Secale cereale.* This is often sown in the fall for winter and spring pasture. Mr. Ramsey, of Mitchell county, recommends utilizing rye in this way in order to rest the native pasture in the spring. He allows his sheep to graze the forage entirely down, by which time the native grass has made a good start. This most excellent practice is one of the methods by which native pastures may be prevented from deteriorating.

Winter wheat is often lightly grazed, especially when the fall has been favorable for luxuriant growth. Oats are sometimes sown for spring pasture.

MICELLANEOUS FORAGE PLANTS.

RAPE. *Brassica napus.* A native of northern Europe. It belongs to the mustard family, and is a close relative of the turnip and cabbage. It has long been cultivated in Europe, both for forage and for the seed, from which an oil is produced. In this country, it has been grown in recent years to a considerable extent in northern United States, and more especially in Canada. Under favorable conditions it produces a large amount of succulent forage of high feeding value. It is excellent for sheep, but it is also valuable for other stock. Although it is best adapted to cool, moist climate, yet experiments show that it can be utilized in Kansas, and, when properly handled, will be a valuable addition to our list of forage plants.

It does best on rich loam. Land that will produce a good corn crop is suited to rape. It can be sown at any time from spring to fall, depending on when the forage is desired. It is ready for use in about ten weeks from planting. About thirty-three pounds of seed per acre are usually sufficient. It is best to sow in drills far enough apart for cultivation. Cultivation is quite necessary in Kansas, where the moisture must be conserved as much as possible.

Rape can be used as a catch-crop after wheat or other early crops; or it can be used in connection with rye for pasture—rye in winter, and rape sown after the rye has been pastured down. As a catch-crop it may be sufficient to drill in after a good disking. It is used for soiling, or can also be used as pasture for sheep or hogs. Cattle waste so much that it is better to mow and feed it green to them. When pasturing sheep or cattle upon it, care should be taken to prevent bloating, by not allowing them to feed too heavily or when the rape is wet. Since it is not easily frosted, rape makes an excellent late feed.

Rape should not be grown successively on the same land, but should be rotated with other crops. Experience has shown that wheat follows rape better than does corn. In our experimental plats rape made a most vigorous growth. It was planted April 20 and continued green and succulent until late in the fall. The Dwarf Essex variety was used. It showed no sign of seeding. The plants grew to the heighth of thirty inches, and one individual was four feet in diameter. Mr. W. F. Ramsey, of Blue Hill, Mitchell county, a sheep raiser, and Mr. Shinn, of Star Church, Jewell county, both have used rape with excellent results.

AUSTRALIAN SALT-BUSH. *Atriplex semibaccata.* This and other species are important forage plants of Australia, and several kinds have been tried with more or less success in the arid regions of the southwestern United States, especially California.

The above species tried by us proved very successful in our plats, producing a large amount of succulent forage which was little affected by drought or early frosts. The soil upon which it was grown was not alkali. The salt-bushes are said to thrive better on alkali than on ordinary soils. In Kansas, the perennial salt-bushes tend to winter-kill, and hence must be treated as annuals. We would recommend their trial on alkali soils, as they are about the only forage plant that will thrive there. It has been found that the soil must be warm and moist for the germination of the seed, and also that it is best to sow the seed on the surface and press in rather than cover.

GIANT SPURRY.

GIANT SPURRY. *Spergula maxima.* A low-growing annual, forming a tangled mass. It made a fairly vigorous growth in our experimental plat, and is worth a trial on sandy soil, but otherwise is probably not to be recommended for Kansas.

COMMON MORNING-GLORY. *Ipomœa hederacea.* This is not generally recognized as a forage plant, but one of our correspondents, Mr. J. Clarence Norton, of Moran, Kan., recommends it so highly that we have tried it. He says of it:

"I expect to sow ten or fifteen acres of morning-glories for sheep. They will yield forty tons of green feed per acre, are drought proof and very highly nutritious, equal to the best clover, and can be cut, cured, and thrashed. I sow them all over my farm. Sheep annihilate them. They never go to water when they can get them. They can be sown in young cultivated corn and the whole cut up and shocked. They will cut five to seven tons of dry feed per acre."

Mr. E. K. Carr of Kerrville, Tex., also recommends the plant for sheep. The species referred to is the annual kind, with purple flowers, and not the white-flowered perennial form.

There is no doubt but morning-glories will give a fairly certain and abundant crop. We fed some from our plat to horses, and the leaves were eaten though the stems were not. If all are as successful with the plant as has been Mr. Norton it is certainly a valuable forage plant for Kansas. One should take into consideration the fact that it is a noxious weed. Since it is not a legume it will not act as a soil renovator.

CULTURE OF FORAGE CROPS.

The following circular was sent out to a few of our correspondents in order to obtain information concerning the culture of the common forage crops:

The Experiment Station of the Kansas Agricultural College wishes to obtain information concerning the best methods of growing our cultivated grasses and forage plants. We wish to have the cooperation of our correspondents through the state, and ask if you will kindly give us your experience with any of the forage plants mentioned in the list below.

We append an outline which will aid in giving your results. It is intended to issue a bulletin embodying the results of the inquiries, and all our correspondents will receive due credit at that time. Information is especially desired upon the following points:

Method of preparing the soil and planting the seed.

Amount of seed per acre.

State if it is advisable to plant a mixture, and if so, what mixture is most suitable for the purpose.

What kind of soil is preferred?

What treatment do you give the crop the first year?

State whether the crop is raised for hay or pasture.

If for hay, at what stage should it be cut?

If for pasture, at what season can it be used without damaging the pasture?

For what kind of stock is the crop best adapted?

How many years will a field yield profitable crops, or how long can it be pastured?

List of cultivated grasses and forage plants more or less grown in Kansas:

Pasture Grasses.— Timothy, orchard-grass, English blue-grass, Kentucky blue-grass, Texas blue-grass, redtop, Johnson grass, Awnless brome-grass.

Fodder Grasses.— Millet (Hungarian, German, Italian, or Common), Pearl millet, Texas millet, Indian millet, cane or sorghum.

Clovers.—Red clover, White clover, Alsike clover, Mammoth clover.

The following persons sent in answers to the circular:

J. M. Alexander, Welda, Anderson county.
A. H. Diehl, Enterprise, Dickinson county.
G. P. Jones, Elco, Lyon county.
D. R. Menke, Garden City, Finney county.
J. C. Norton, Moran, Allen county.
C. J. Reed, St. Clere, Pottawatomie county.
E. W. Reed, St. Clere, Pottawatomie county.
Jesse Royer, Ogallah, Trego county.
H. Shideler, West Mineral, Cherokee county.
Edwin Snyder, Oskaloosa, Jefferson county.
W. P. Symns, Rendena, Doniphan county.
E. C. Trembly, Comiskey, Morris county.
F. E. Uhl, Gardner, Johnson county.
Fred Zimmerman, Moray, Doniphan county.

From various sources, including the replies mentioned above, the following notes on culture have been compiled:

MILLETS.

The best soil is a fertile, mellow loam, without too much clay or sand. The millets are surface feeders and give quick returns from top dressing with manure, but they are only moderate in their ability to resist drought. The seed is usually sown after corn planting. By this time the weeds have started, and the necessary preparation of the soil destroys these and gives the millet a start over those that come later. The seed-bed should be compact and the seed sown broadcast and harrowed in. It is usually sown alone, though some recommend sowing with sorghum. It is sometimes sown as a catch-crop after some early maturing crop has been gathered. In this case the stubble may be disked or cultivated and the seed harrowed in. It is even sown on newly broken sod which has been disked or harrowed. The seed may be put in with a grain-drill, especially if grown for seed or for ensilage, as there is likely to be a better and more even stand, and somewhat less seed is required. About one-half bushel of seed is required per acre. Some use more or less, according to the conditions. The hay should be cut between the time of complete heading out and that of late bloom; at least not later than the dough stage of the grain. If the seed is allowed to mature it has a more or less injurious effect upon the stock eating it, especially upon horses. If cut too early it has a laxative effect, and the hay is not so nutritious. The hay, being succulent, cures slowly. It is usually cured in the cock and then stacked. Yields of five tons per acre are not uncommon. German millet is preferred by some on account of its larger size.

SORGHUM.

The soil should be reasonably free from weeds. If it is weedy some preliminary treatment is necessary, since the seed is not sown until the ground is warm, at which time the weeds are ready to make a vigorous start. The seed may be sown broadcast and harrowed in, or it may be drilled or planted thickly in rows about thirty-two inches apart and cultivated. Listing is sometimes employed, but there are many objections to this method, largely due to the slow early growth of cane. About one and one-half to two bushels of seed per acre are sufficient. In the western part of the state one-half to one bushel is recommended by our correspondents. In the Eastern and Southern states, and sometimes in Kansas, sorghum is cut and feed green; but with us it is commonly cured for winter feed. It is usually cut with a mower about the time the seed is in the dough stage. It is allowed

to partially dry and then piled in cocks or bunches in such a way as to turn water as much as possible. Some allow it to remain in these bunches until needed for feed; others allow it to cure in this way and then stack it. In the central and western parts of the state it seems to keep sufficiently well in the bunches, thus saving the labor of stacking. Sorghum should, however, be fed during the fore part of the winter, as the alternate freezing and thawing during the latter part of the feeding season cause it to deteriorate.

A method of harvesting which finds much favor with some is to harvest with a corn-binder, when the seed has been sown thickly in rows, as was suggested above.

In many cases more than one cutting can be made. The yield of forage from sorghum is sometimes very large—five to ten tons, according to conditions.

TIMOTHY.

In Kansas timothy is usually sown with clover, since the former helps to hold the latter in an upright position. The presence of the timothy also lessens the danger from bloating when cattle are pastured upon the mixture, which makes a more evenly balanced ration than either alone. The usual practice is to sow the timothy in the fall, often with wheat, by a special attachment to the drill, and the following spring sow the clover broadcast. Others sow the timothy early in the spring, and afterwards, about the 1st of April, the clover. Still others advocate sowing the clover in the spring and the timothy in the following fall. The amount of seed of the mixture per acre should be six to eight quarts of timothy and eight to ten pounds of clover. One correspondent recommends about a gallon of the mixture per acre, of which one-third is timothy. If sown alone, there should be used about eight to sixteen quarts per acre. It is best to cut for hay when the flowers are falling. It does not seem to be used alone or with other grasses for permanent pastures to any extent in Kansas. Our correspondents having timothy and clover mixed do not mention any injury to the timothy from grazing. Mr. Shinn, of Jewell county, states that he has a field of timothy four years old which is in good condition. This shows the possibility of utilizing this grass farther west than is generally supposed.

RED CLOVER.

As described under the head of "Timothy," Red clover is usually sown with that grass for both hay and pasture. Some plow up the clover at the end of the second year, others at the end of the third year. A few state that they have been able to maintain the field indefinitely by allowing the seed to shatter. On account of its renovating power, it is best to rotate this with other crops. It should have a fine, com-

pact seed-bed and not to be sown until danger of frost is past. It grows best on rich loams where there is plenty of humus. It does not succeed so well on stiff clays or on sandy soils. It requires lime, but there is plenty of that material in most parts of eastern Kansas. The seed is usually sown broadcast and harrowed in, though Mr. Henry Wallace recommends that the seed be covered to the depth of about two inches. From ten to fifteen pounds of seed are used per acre when sown alone.

It may be pastured lightly the first season, after July 1, and the second season from early spring until November. If cut for hay, it should be mowed when about one-third of the beads are turning brown. The value of the hay depends much upon the care with which it is cured. It should be as dry as possible and yet retain the foliage.

MAMMOTH AND OTHER CLOVERS.

Mammoth clover has been grown in the state for twenty-five years. It can be grown on a greater variety of soils than Red clover, and on heavy, moist soils makes a very rank growth. It is claimed that it will produce one-half more forage per acre than Red clover. The ground is prepared as for Red clover. Sometimes oats or flax are used as a nurse crop. It is sown alone, or more frequently with half its weight of timothy. It is sown about April 15, and the weeds kept off the first season by mowing. It may be pastured lightly the first fall. Mr. J. C. Norton, Moran, Allen county, states that it should be cut when about half the heads have come in bloom.

Alsike clover is not much grown in Kansas. It is used in mixtures with tame grasses for pastures and in fields too wet for cultivated crops.

White clover is used only for pasture, and is usually associated with Kentucky blue-grass. It endures pasturing and drought well, and grows on soil that will not support other tame-pasture constituents. In mixtures, one to three pounds of seed are used per acre.

TEE RENOVATION OF WORN-OUT NATIVE PASTURES.

The solution in case of pastures of cultivated grasses or forage plants is usually to break up the field and begin over again. But a study should be made of the causes which brought about the condition. It may have been that the stand was poor in the first place, due to having the soil in improper condition when the seed was sown; or the plants used may not have been suited to the conditions; or the land may have been worn out by previous culture, and may have needed fertilizing. The remedy would be applied as indicated by the cause. As stated above, it will usually be necessary to start the pasture anew. But in some cases a pasture may receive benefit by the same treatment recommended for native pastures. Over the

greater part of Kansas, at least the western two-thirds, we would strongly advise the retention as far as possible of the native prairie sod for pasture purposes. The grasses are adapted by ages of selection to the prevailing conditions. Although there are several valuable forage plants that can be grown in these regions, and with proper culture may and should yield more forage than the native grasses, yet in all cases these plants are better adapted for hay or for soiling than for pasture.

Practically the only danger of injury to a native-grass pasture comes from overstocking or, what amounts to the same thing, too close grazing at critical periods. Under normal conditions the grass is able to withstand the inroads of weeds, but when too closely cropped the perennial weeds gradually encroach, or, if the grass is entirely destroyed over areas of greater or less extent, annual weeds make their appearance. These weeds are disliked, or at least less relished by stock, and go on in their development unhindered. The first thing to do in all cases where renovation is desired is to remove the stock and give the pasture a rest for at least one whole season. If the pasture is only beginning to show signs of deterioration it may not be necessary to remove all the stock, but to decrease the number somewhat below what would be sustained by the pasture, or the stock may be removed for half the season; but when the pasture is in bad condition it is necessary to do more than this, or otherwise it might take several seasons for the grass to regain its ascendency over the weeds. Experiments in various places have shown that the best treatment is to remove the stock and give the pasture a thorough harrowing, or better still a disking, in the spring. This treatment tears up the sod and enables the rootstocks of the desirable grasses to spread with freedom. In addition, it is best to mow the pasture when the weeds have attained their growth but before they have gone to seed. The sickle should be set high, so as to do as little injury to the grass as possible. By proper attention to stocking the pasture, an application of the disk harrow in the spring over the affected parts, and mowing when necessary, a prairie pasture can be kept in good condition. In small pastures, where it is not practicable to remove the stock, the pasture may be prevented from deterioration by providing soiling crops during the season, especially the early part, until the grass is well started, and again during the dry period, which usually occurs in August or September.

CULTIVATION OF NATIVE GRASSES.

Our native grasses are adapted to the conditions prevailing upon our grazing lands. There is little doubt but several of the species would prove desirable forage plants under proper cultivation. The

chief difficulty at present is the fact that the seed of these species is not upon the market. Furthermore, some of the desirable sorts, such as bluestem, seem to produce seed in small quantities. This is likely to be true of perennials under such conditions. The prairie sod is in a comparatively permanent condition. The ground is fully occupied by the perennial grasses and a few other plants, and only occasionally is there a chance for seeds to germinate in new soil. Such opportunities are given by the turning up of new ground, but in nature this takes place only when the sod is disburbed by animals such as prairie-dogs and gophers, or by the tramping of larger animals, such as the buffalo. But when this occurs it will be observed that there are certain species of grasses that are particularly adapted to occupy such places. These species are usually those that are of little importance as grazing grasses. It has thus come about that the important grazing grasses have to a considerable extent lost the power to produce good seed, and depend for their propagation upon rootstocks or other means of vegetative extension.

However, judging from the tendencies of other plants, it is very probable that our valuable grazing grasses could be cultivated and the tendency to produce seed be very materially increased. By repeated harvesting and sowing the seed of these grasses from year to year, the seed-bearing tendency is gradually increased, since the individuals produced must come from others which have possessed the power to produce seed. In pursuance of this plan, several of our grasses were cultivated in this way in our grass plats. The results so far have been very gratifying. Since the soil used was badly infested with crab-grass, we were obliged to give the plats extra attention when the young grass was starting. At the end of the season the bluestem and prairie oats gave a most luxuriant growth. The seed has been gathered, and the experiment will be continued. Prairie oats is especially to be recommended for this purpose, since the seed is produced on the upper part of the seed-stalk and at a fairly uniform height from the ground. The seed-stalks are numerous, giving a thick stand where the grass is growing alone. All these qualities are favorable for the gathering or harvesting of the seed on a commercial scale. A field of this grass could be harvested in the same way as timothy and the seed thrashed out. Any farmer or stock-grower could make a start along this line for himself. Big bluestem also gave good results, although the seed is not produced in such quantity nor at a uniform height.

OBSERVATIONS ON THREE NATIVE PASTURES.

In determining the botanical composition of the pastures, a typical square rod was laid off in a pasture which represented a certain class of our native pastures. The entire vegetation was removed from the plat chosen and carried to the laboratory, where the species were separated, counted, and, when dry, weighed.

AN UPLAND PASTURE IN AVERAGE CONDITION.

Observations begun July 31, 1900, and concluded August 15, 1900. Location, east slope of a pasture one mile southwest of the College. The pasture had been burned quite late in the spring, and, as a consequence, fully half of the Little bluestem was killed out, the burned stubs still showing at the date observed. The other grasses, not being of a bunching habit, were not badly injured. The species whose total weight aggregated less than one-half ounce were estimated, as the weights are given to assist in forming an idea of the relative importance of the various species present. The area is just below a limestone outcrop but is not stony, at least not on the surface. This may be considered as a representative pasture, being grazed but not in bad condition. It will be observed from the table that there is a total of 19,311 plants, aggregating in weight 278.39 ounces, or about 17.4 pounds.

Common name.	Scientific name.	Number.	Wt.(oz.)
Lead plant.....	*Amorphacanescens*.....	615	8.5
Big bluestem.....	*Andropogonfurcatus*.....	2,073	34.0
Little bluestem.....	*Andropogonscoparius*.....	8,992	132.0
Blue aster.....	*Aster azureus*.....	7	1.0
Many-flowered aster....	*Aster multiflorus*.....	496	4.5
Rigid aster.....	*Aster oblongifolius rigidulus*..	126	2.0
Silky aster.....	*Aster sericeus*.....	5	.5
Indian tobacco.....	*Antennaria campestris*.....	38	1.0
Prairie oats.....	*Bouteloua racemosa*.....	3,683	56.5
Hairy grama grass.....	*Bouteloua hirsuta*.....	10	.5
Prairie sedge.....	*Carex pennsylvanica*.....	990	7.0
New Jersey tea.....	*Ceanothus ovatus*.....	52	3.0
Indian grass.....	*Chrysopogon avenaceum*.....	742	10.0
Stick-tights.....	*Desmodium illinoense*.....	2	.06
Rigid sunflower.....	*Helianthus rigidus*.....	19	1.5
Blazing-star.....	*Liatris scariosa*.....	1	.33
Indian puccoon.....	*Lithospermum canescens*.....	13	.06
Buttercup primrose.....	*Œnotheraserrulata*.....	13	.25
Yellow wood-sorrel.....	*Oxaliscorniculata*.....	6	.1
Hairy panicum.....	*Panicum pubescens*.....	1,033	7.5
Milkwort.....	*Polygala verticillata*.....	5	.8
Wild sage.....	*Salvia azureus*.....	7	1.0
Rosin weed.....	*Silphium laciniatum*.....	1	1.0

Common name.	Scientific name.	Number.	Wt. (oz.)
Bull nettle	*Solanum rostratum*	1	.1
Sumac	*Rhus glabra*	2	.5
Wild rose	*Rosa arkansana*	2	.16
Wild petunia	*Ruellia ciliosa*	4	.08
Skullcap	*Scutellaria parvula*	2	.03
Golden-rod	*Solidago canadensis*	57	1.5
Golden-rod	*Solidago rigida*	11	1.5
Sow thistle	*Sonchus asper*	2	.04
Drop-seed grass	*Sporobolus cryptandrus*	287	3.0
Prairie violet	*Viola pedatifida*	14	.5

AN UPLAND PASTURE IN POOR CONDITION.

Observations begun August 20, 1900, and concluded September 3, 1900. Location, one mile south of College, on an east slope, in an overgrazed, weedy pasture. Total number of plants, 14,366, having a weight of 143.5 ounces, or 8.9 pounds.

Common name.	Scientific name.	Number.	Wt. (oz.)
Milkweed	*Acerates viridiflora lanceolata*	1	.025
Milkweed	*Acerates viridiflora*	1	.1
Water hemp	*Acnida tuberculata*	2	.003
Perennial ragweed	*Ambrosia psilostachya*	383	16.0
Lead plant	*Amorpha canescens*	4	.04
Big bluestem	*Andropogon furcatus*	431	3.0
Little bluestem	*Andropogon scoparius*	1,093	9.0
Rigid aster	*Aster oblongifolius rigidulus*	195	7.5
Silky aster	*Aster sericeus*	5	.2
Small ground plum	*Astragalus lotiflorus*	5	.02
Hairy grama grass	*Bouteloua hirsuta*	8,675	13.0
Prairie oats	*Bouteloua racemosa*	879	4.0
Chloris	*Chloris verticillata*	53	.5
Indian grass	*Chrysopogon avenaceum*	35	.25
Stink grass	*Eragrostis major*	1	.003
Purple cone-flower	*Echinacea angustifolia*	23	1.0
Sunflower	*Helianthus annuus*	21	3.0
Houstonia	*Houstonia angustifolia*	2	.005
Snow-on-the-mountain	*Euphorbia marginata*	23	1.5
Mock pennyroyal	*Hedeoma hispida*	4	.01
Kuhnia	*Kuhnia eupatorioides*	231	7.5
Blazing-star	*Liatris punctata*	12	1.5
Indian puccoon	*Lithospermum canescens*	13	.5
Evening primrose	*Œnothera missouriensis*	7	.5
Tickle grass	*Panicum capillare*	68	.5
Foxglove	*Pentstemon cobœa*	14	1.0
Prairie clover	*Petalostemon violaceus*	38	.5
Wild petunia	*Ruellia ciliosa*	1	.02
Wild sage	*Salvia azurea*	290	11.5
Bull nettle	*Solanun rostratum*	29	.5
Golden-rod	*Solidago canadensis*	200	20.0
Golden-rod	*Solidago rigida*	170	19.0
Drop-seed grass	*Sporobolus cryptandrus*	59	.33
Wild verbena	*Verbena stricta*	1,403	26.0

AN UPLAND PASTURE IN GOOD CONDITION.

For the sake of comparison, a piece of upland prairie was examined which had been but slightly pastured, and will represent fairly well the grass land in good condition. The weights of the plants were not obtained. Beside those mentioned, several other species were scattered over the area in smaller numbers.

Common name.	Scientific name.	Number.
Big bluestem	*Andropogon furcatus*	16,940
Little bluestem	*Andropogon scoparius*	9,831
Silky aster	*Aster sericeus*	181
Short grama	*Bouteloua hirsuta*	98
Prairie oats	*Bouteloua racemosa*	260
Indian grass	*Chrysopogon avenaceum*	300
Purple cone-flower	*Echinacea angustifolia*	5
Prairie clover	*Petalostemon violacea*	15
Golden-rod	*Solidago canadensis*	40
Golden-rod	*Solidago rigida*	110

INVESTIGATIONS ON NATIVE PASTURES.

In order to obtain information upon certain points concerning our native pastures, the following circular was sent to a few of our correspondents:

1. What is the average number of acres allowed per head upon the different kinds of pastures in your vicinity, and in your opinion is this too large or too small?
2. To what extent has the grazing capacity of the pastures varied in the last several years?
3. What can you say as to the effects of overpasturing in small pastures and also on the large ranges?
4. What are the worst pasture weeds?
5. What is the general practice and what is your opinion concerning the burning of pastures?
6. The same for mowing to remove weeds?
7. Can you give any information concerning disking for removing weeds or for renovating either wild or tame pastures?
8. Do you know of any results from seeding or otherwise renovating native pastures? It would be desirable to indicate the number of head of stock supported by the pasture before and after treatment.
9. Can sumac be eradicated by cutting in August?
10. What statement can you make concerning the use of auxiliary foods during the dry period?
11. Has dividing the pasture and pasturing the two portions alternately during the season been tried, and with what effect?
12. What seem to be the best grasses for spring pasturage; summer pasturage; fall pasturage?

List of those aiding in giving information concerning pastures:

E. Bartholomew, Rockport, Rooks county.
Wallace Birch, Manhattan, Riley county.
R. W. Bishoff, Eudora, Douglas county.
E. E. Chase, Merriam, Johnson county.
M. Clark, Manhattan, Riley county.
E. L. Cottrell, Wabaunsee, Wabaunsee county.
L. A. Fitz, Vinland, Douglas county.
L. S. Fry, Manhattan, Riley county.
A. C. Havens, Dwight, Morris county.
H. McCaslin, Barnes, Marshall county.
R. A. Oakley, Reedsville, Marshall county.
S. G. Philips, Arkansas City, Cowley county.
T. L. Pittman, Hammond, Bourbon county.
E. A. Powell, Osage City, Osage county.
F. C. Romig, Curran, Harper county.
J. T. Ryan, Angola, Labette county.
H. K. W. Taylor, Nickerson, Reno county.
J. H. Taylor, Chapman, Dickinson county.
M. J. Tully, Westgate, Geary county.
John Warner, Manhattan, Riley county.
E. W. Westgate, Manhattan, Riley county.
H. Westgate, Westgate, Geary county.
J. C. Wilkin, Bow Creek, Phillips county.

The following notes have been compiled from the answers given: The number of acres allowed per head (neat cattle) on native pasture seems to be about two in the eastern part, but the amount required increases as a rule towards the western part of the state. The following is a tabulated statement of definite answers to the first question:

NAME.	County.	Acres per head.	Remarks.
J. T. Ryan	Labette	2½	Too small an allowance.
S. G. Philips	Cowley	2	Too small an allowance.
E. A. Powell	Osage	2½	
E. Cottrell	Wabaunsee	4	Correct for uplands; less for bottoms.
H. Westgate	*Geary*	3	The proper allowance as a rule.
M. J. Tully	"	3	
A. C. Havens	Morris	1½ to 3	
J. H. Taylor	Dickinson	2	Allowance too small in dry years.
E. Bartholomew,	Rooks	4	Too small; five would be better.
J. C. Wilkin	Phillips	5	Correct unless season be very dry.
H. K. W. Taylor,	Reno	2 to 4	Too small an allowance.

It is generally admitted that as a rule the grazing capacity of the native pastures has decreased in the last few years, and that this is the result of overpasturing.

The worst weeds are reported as follows: Western part, thistles and loco; central part, perennial ragweed, kuhnia, golden-rod, iron weed,

and snow-on-the-mountain; central part, yellow-top, eryngium, spear-grass, sumac, and scrub oak.

The concensus of opinion is unfavorable towards the policy of burning pastures. In special cases it may be wise to resort to burning, as for the destruction of brush, weeds, or bunch grass.

On the other hand, it is generally recognized that mowing pastures is an excellent method for keeping down weeds. This, however, is not practicable in large pastures or on the range.

Disking of wild pastures is not reported. The use of soiling or other auxiliary forage crops during the growing season is uncommon in the western two-thirds of the state.

But one instance was reported of dividing native pasture, as was indicated in question 11, although it is a rather common practice with tame pastures.

The only grasses reported as conspicuously valuable are the blue-stems, grama grasses, and buffalo-grass.

TABLES.

I.— Average percentage composition of certain forage plants. The nitrogen-free extract is mostly *carbohydrates, and the ether extract is mostly fat. (From Henry's "Feeds and Feeding.")*

KIND OF FORAGE.	Water.	Ash.	Protein.	Crude fiber.	Nitrogen-free extract.	Ether extract.
Corn-fodder, field cured	42.2	2.7	4.5	14.3	34.7	1.6
Corn forage, green, dent	79.0	1.2	1.7	5.6	12.0	0.5
Timothy hay, cut in full bloom	15.0	4.5	6.0	29.6	41.9	3.0
Timothy hay, cut soon after bloom	14.2	4.4	5.7	28.1	44.6	3.0
Timothy hay, cut when nearly ripe	14.1	3.9	5.0	31.1	43.7	2.2
Orchard-grass hay	9.9	6.0	8.1	32.4	41.0	2.6
Redtop hay, cut in bloom	8.7	4.9	8.0	29.9	46.4	2.1
Hungarian grass hay	7.7	6.0	7.5	27.7	49.0	2.1
Meadow fescue hay	20.0	6.8	7.0	25.9	38.4	2.7
Johnson grass hay	10.2	6.1	7.2	28.5	45.9	2.1
Kentucky blue-grass, fresh	65.1	2.8	4.1	9.1	17.6	1.3
Timothy, fresh	61.6	2.1	3.1	11.8	20.2	1.2
Orchard grass, in bloom, fresh	73.0	2.0	2.6	8.2	13.3	0.9
Redtop, in bloom, fresh	65.3	2.3	2.8	11.0	17.7	0.9
Hungarian grass, fresh	71.1	1.7	3.1	9.2	14.2	0.7
Meadow fescue, in bloom, fresh	69.9	1.8	2.4	10.8	14.3	0.8
Red clover, in bloom, hay	20.8	6.6	12.4	21.9	33.8	4.5
Red clover, Mammoth, hay	21.2	6.1	10.7	24.5	33.6	3.9
Alsike clover hay	9.7	8.3	12.8	25.6	40.7	2.9
Alfalfa hay	8.4	7.4	14.3	25.0	42.7	2.2
Red clover, fresh	70.8	2.1	4.4	8.1	13.5	1.1
Alsike clover, fresh	78.4	2.0	3.9	7.4	11.0	0.9
Crimson clover, fresh	80.9	1.7	3.1	5.2	8.4	0.7
Alfalfa, fresh	71.8	2.7	4.8	7.4	12.3	1.0
Cowpea, fresh	83.6	1.7	2.4	4.8	7.1	0.4
Flat pea, fresh	66.7	2.9	8.7	7.9	12.2	1.6
Spurry	75.7	4.0	2.0	4.9	12.7	0.8
Rape	84.5	2.0	2.3	2.6	8.4	0.5

II.– Average digestable nutrients. Number of pounds nutrients in each 100 pounds of material. (From Henry's "Feeds and Feeding.")

Kind of Forage.	Protein.	Carbo-hydrates.	Ether extract.
Corn-fodder, green	1.0	11.6	0.4
Corn-fodder, field cured	2.5	34.6	1.2
FRESH GRASSES.			
Kentucky blue-grass	3.0	19.8	0.8
Timothy	1.2	19.1	0.6
Orchard-grass, in bloom	1.5	11.4	0.5
Redtop, in bloom	2.1	21.2	0.6
Rye	2.1	14.1	0.4
Sorghum	0.6	12.2	0.4
Meadow fescue, in bloom	1.5	16.8	0.4
Hungarian grass	2.0	16.0	0.4
HAY.			
Timothy	2.8	43.4	1.4
Orchard-grass	4.9	42.3	1.4
Redtop	4.8	46.9	1.0
Hungarian grass	4.5	51.7	1.3
Meadow fescue	4.2	43.3	1.7
FRESH LEGUMES.			
Red clover	2.9	14.8	0.7
Alsike in bloom	2.7	13.1	0.6
Crimson clover	2.4	9.1	0.5
Alfalfa	3.9	12.7	0.5
Cowpea	1.8	8.7	0.2
LEGUME HAY.			
Red clover	6.8	35.8	1.7
Mammoth clover	5.7	32.0	1.9
Alsike clover	8.4	42.5	1.5
Crimson clover	10.5	34.9	1.2
Alfalfa	11.0	39.6	1.2
Spurry, fresh	1.5	9.8	0.3
Rape, fresh	1.5	8.1	0.2

III.—Table showing acreage, yield and value of the common forage plants of Kansas during the year 1900. (From Twelfth Biennial Report of the State Board of Agriculture.)

Kind of Forage.	Acres.	Tons.	Value.
Millet	449,853	796,985	$2,585,267
Sorghum, forage and grain	448,798	.....	2,457,304
Milo maize	5,228	13,263	41,859
Kafir-corn	645,186	1,966,217	5,756,285
Jerusalem corn	2,253	5,460	16,245
Timothy	317,039	.....	.....
Clover	219,834	.....	.....
Blue-grass	209,722	.....	.....
Alfalfa	276,008	.....	.....
Orchard-grass	2,960	.....	.....
Other tame grasses	71,608	.....	.....
Prairie hay cut, 1899	.....	1,689,455	5,913,092
Tame hay cut. 1899	.....	1,227,349	5,829,907

IV.— Table showing the weight of seed (pounds per bushel) of some of our tame grasses and forage plants.

Bromus inermis	14	Mammoth clover	60
Timothy	45	Alfalfa	60
Redtop	14	Sand vetch	60
Orchard-grass	14	Millet	50
Meadow fescue	14	Hungarian	48
English blue-grass	22	Cane	56
Kentucky blue-grass	14	Kafir-corn	56
Canadian blue-grass	14	Soy bean	60
White clover	60	Cowpea	60
Red clover	60	Johnson grass	25
Alsike clover	60	Rye	56
Crimson clover	60	Wheat	60

The actual weights vary considerably from the figures given, depending upon the purity and quality of the seed. This is especially true of grass seed, where there may be a large amount of chaff. Redtop varies from 8 to 30, and Meadow fescue from 12 to 26. The clovers are usually heavier than the figures listed. This is especially true of Alsike, which is much heavier—94 to 100 instead of 60.

PLATE I.—Clover plats in Grass Garden—General view.

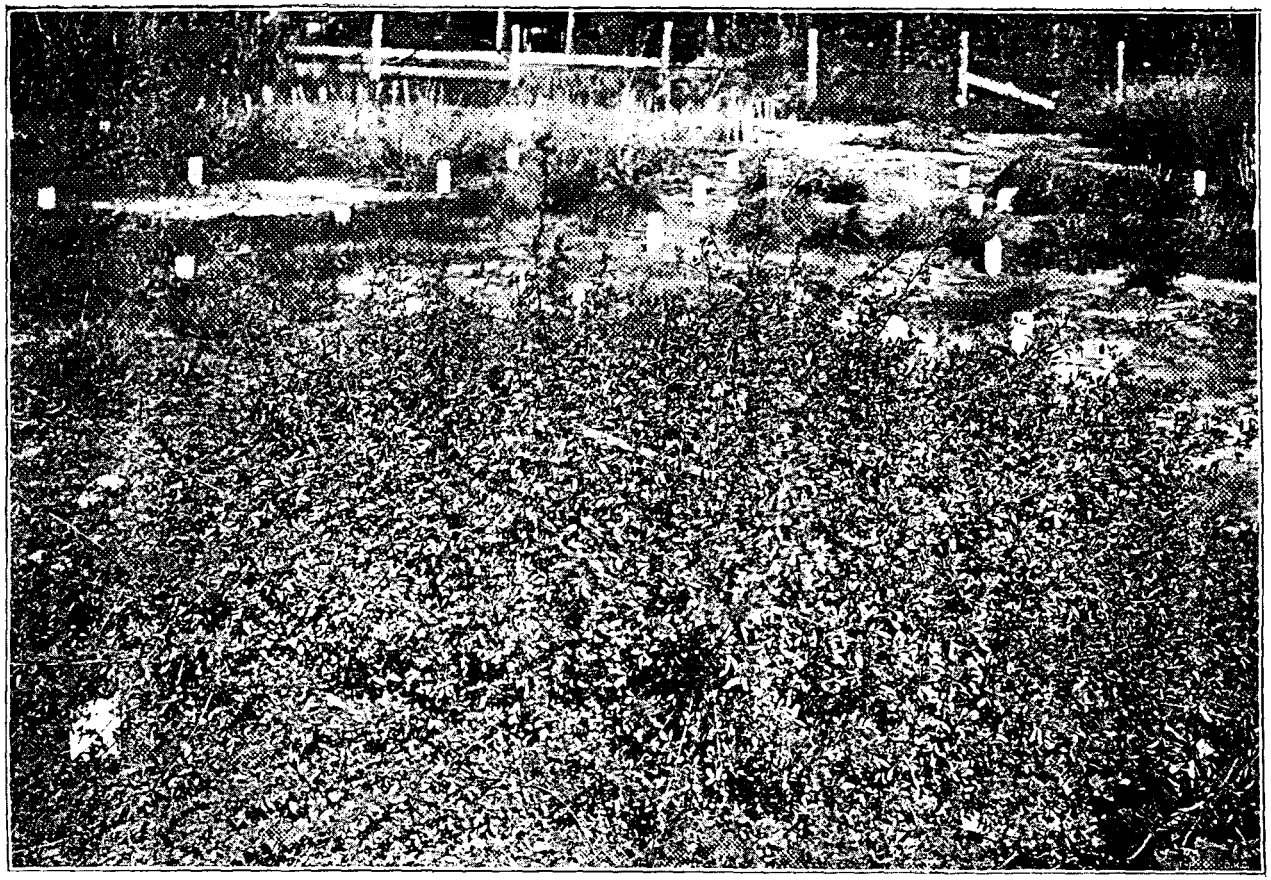


PLATE II.–– Bokhara or Sweet Clover in Grass Garden.

PLATE III.—Big Bluestem in Grass Garden, Grown from Seed.

PLATE IV.—Short's Fescue Grass in Grass Garden.

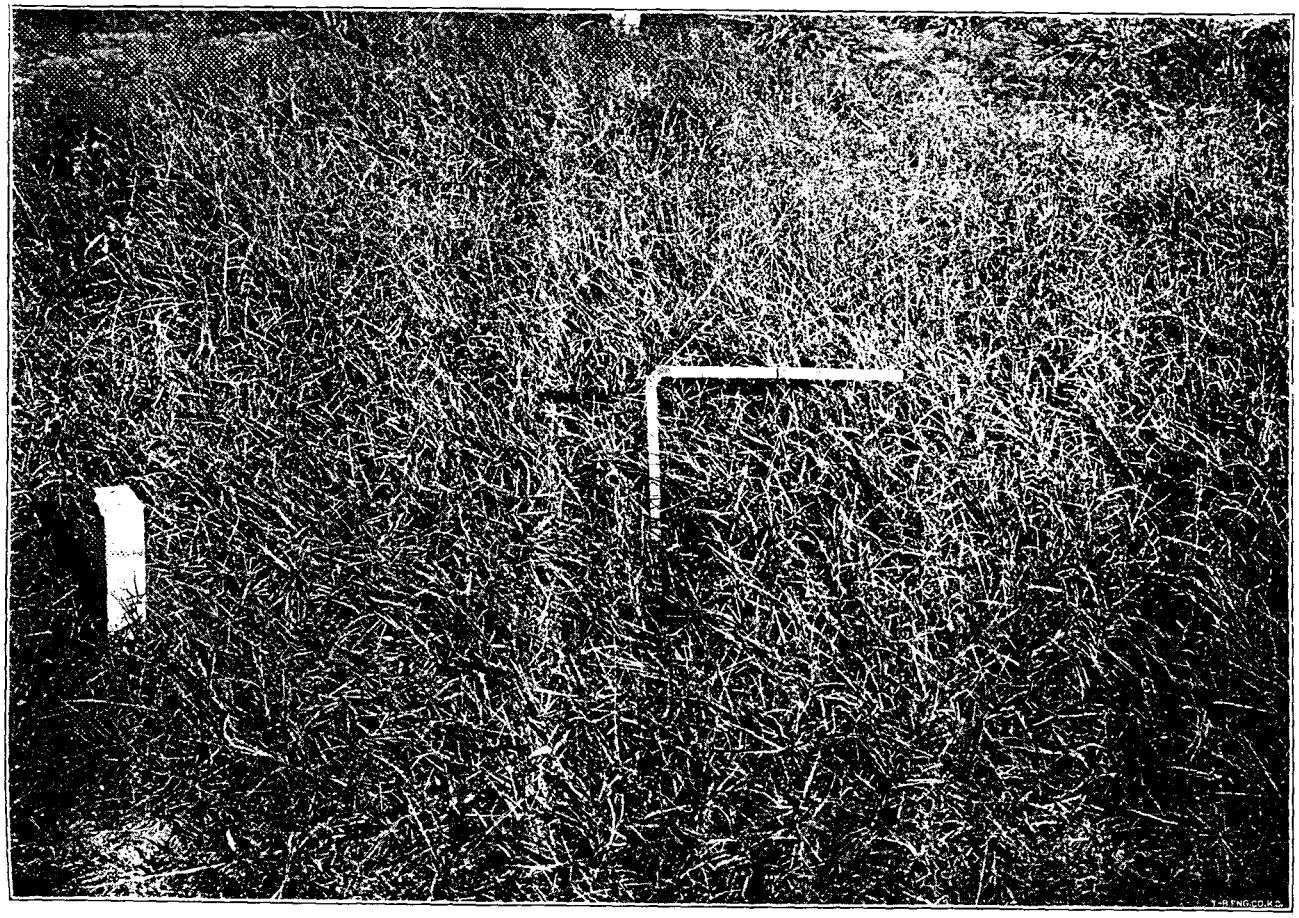


PLATE V.— Bermuda Grass in Grass Garden.

PLATE VI.— Johnson Grass in Grass Garden.

PLATE VII.— Gama Grass in Grass Garden.

PLATE VIII.— *Bromus inermis* in Grass Garden.

PLATE IX.— Rape in Grass Garden.

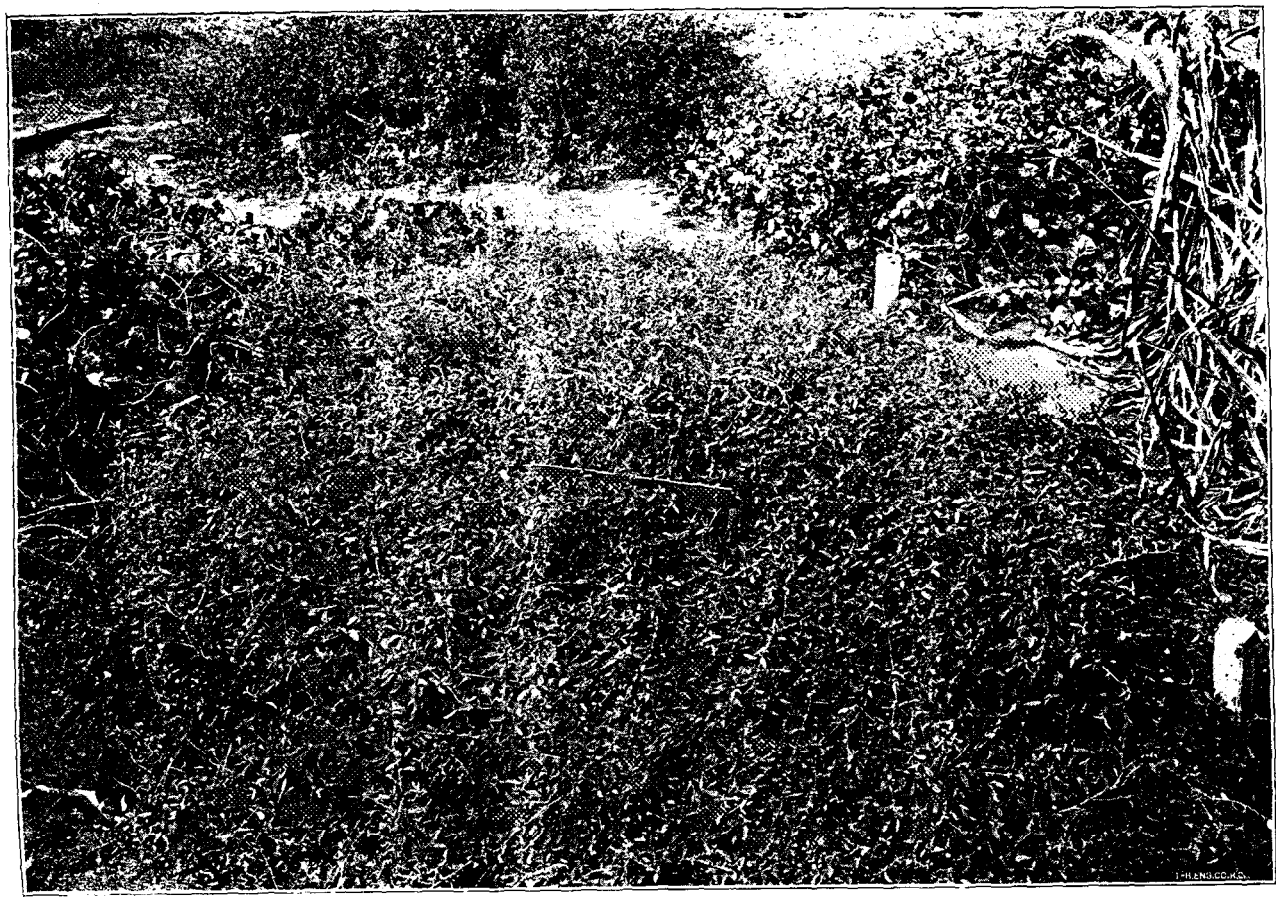


PLATE X.— Australian Salt-bush in Grass Garden.

PLATE XL.— Reed Canary Grass in Grass Garden.

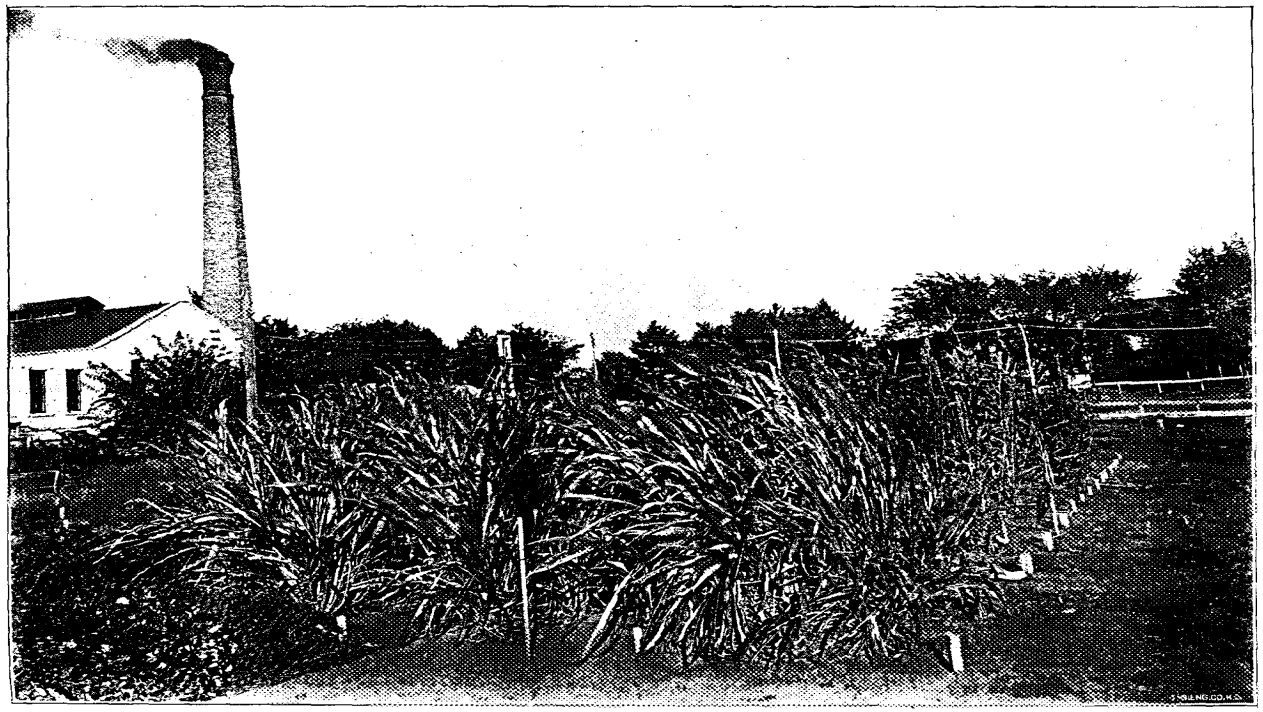


PLATE XII.—– Teosinte in Grass Garden.

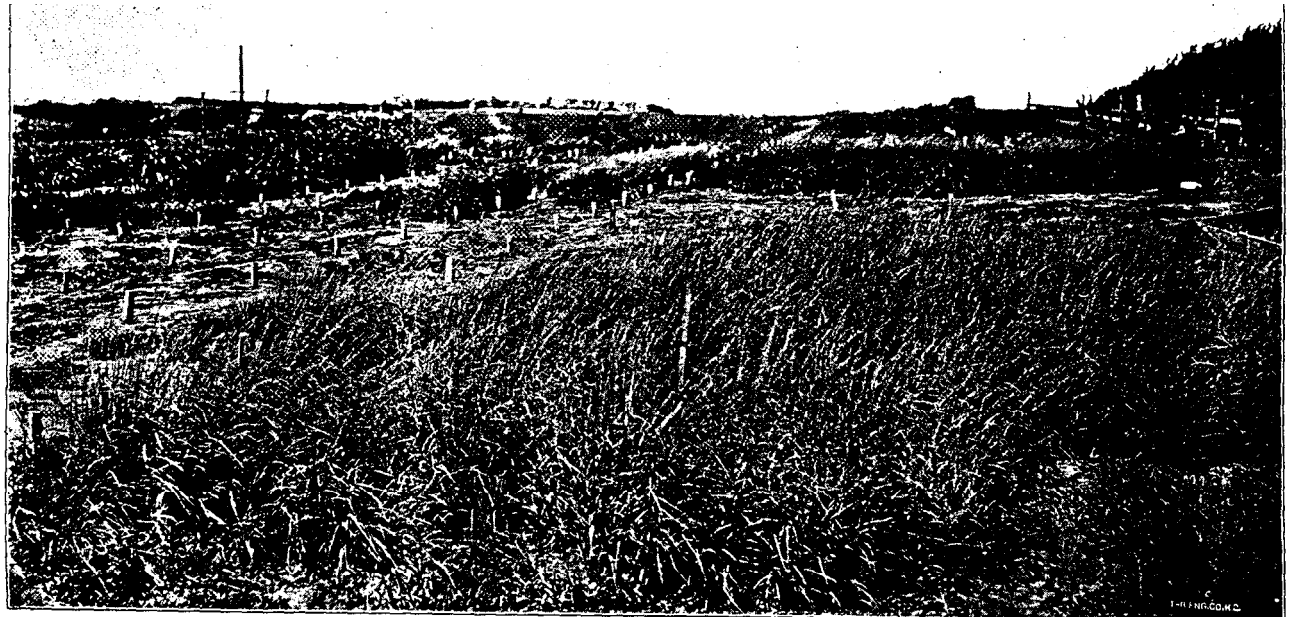


PLATE XIII.—– Prairie Oats, Grown from Seed.

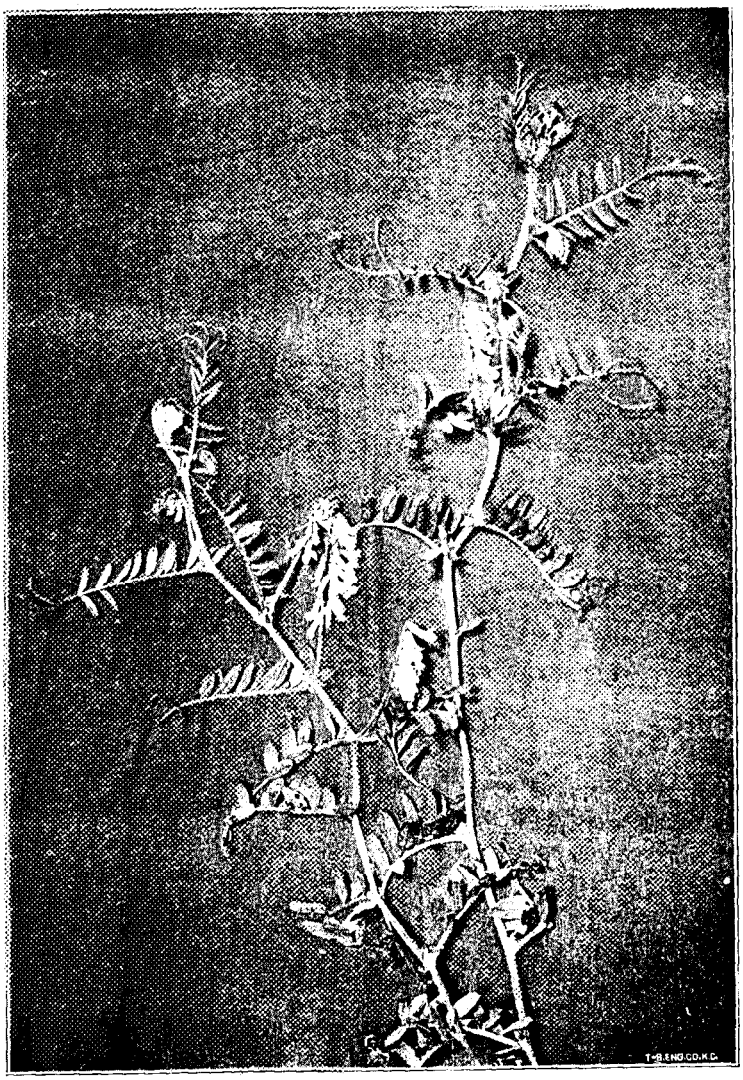


PLATE XIV.— Hairy Vetch (One-half Natural Size).

PLATE XV.– Grassland and Woodland Contending for Supremacy.

PLATE XVI.—Velvet Bean.