A83-1238-8M-L180

TEXAS AGRICULTURAL EXPERIMENT STATION

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BULLETIN NO. 570 JANUARY 1939

DIVISION OF AGRONOMY

Pasture Improvement in the Gulf Coast Prairie of Texas

AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS
T. O. WALTON, President

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As a result of experiments with pasture and forage plants over a period of 25 years at Texas Substation No. 3, Angleton, in the Gulf Coast Prairie, Dallis, Bermuda, carpet, and Angleton grasses, California bur clover (toothed bur clover), White Dutch clover, and common lespedeza are recommended for permanent pastures in the region.

Adequate drainage, mowing to control weeds, and the seeding of desirable and adapted pasture plants contribute to the establishment of good improved pastures. Two years were required to establish a good sod with seeding and mowing, and four years with mowing alone; moreover, the pasture which had been seeded contained more kinds of grasses in a more uniform mixture than the pasture which had been mowed.

Under the practice of mowing twice a year, the tall-growing bluestem grasses were gradually replaced by lower-growing grasses and legumes, as Bermuda grass, carpet grass, and lespedeza.

Improved permanent pasture had a greater carrying capacity, and produced more total gain per steer yearly than the unimproved native pasture. The steers on native pasture gained more rapidly in early spring and reached their highest condition in June, while the steers on the improved pasture continued to gain during the summer and fall and reached their highest condition in October. The better results secured from the improved pasture are ascribed to the more nutritious herbage and to the longer productive grazing period.

When grown in pure stands, the native bluestem grasses produced considerably larger average yields of forage than Bermuda, carpet, Dallis, and Angleton grasses. All of these grasses, except Bermuda, made larger yields when harvested at maturity than when harvested at monthly intervals.

The young succulent growth of grasses harvested at monthly intervals contained more protein, fat, phosphorus, and calcium and was decidedly more palatable than the growths harvested at maturity.

When harvested at monthly intervals, Bermuda, Dallis, and Angleton grasses contained adequate amounts of phosphorus for the nutrition of livestock, while carpet grass and native grass did not. When mature, none of the grasses contained sufficient phosphorus (approximately .13 per cent required) for adequate nutrition. None of the grasses, excepting salt grass, appeared to be deficient in calcium content at any stage of growth. Salt grass, while of relatively low feeding value, was superior to the mature and dead native grasses; hence its value for pasturage during the winter.

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PASTURE IMPROVEMENT IN THE GULF COAST PRAIRIE OF TEXAS

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The Gulf Coast Prairie of Texas occupies a strip of flat country 20 to 80 miles wide along the Gulf of Mexico and extends from the Sabine River on the east to the San Antonio River on the west. The area covers about 8,000,000 acres of land lying within or partly within 19 counties. The topography is smooth and flat and in general the elevation increases about one foot per mile inland from the Gulf. The prairie is a natural grassland area, being covered with a heavy growth of grasses, consisting mainly of the bluestem grasses.

The Prairie has a warm temperate climate, with an average annual temperature of 67° to 70° F. The average growing season, that is, from the last killing frost in the spring to the first killing frost in the fall, is about nine months. The average yearly rainfall is about 50 inches in the eastern part and 35 inches in the western part of the area.

The soils in the Gulf Coast Prairie have been developed largely from marl under a heavy grass vegetation and humid climate. The soils differ considerably and on the basis of their characteristics have been divided into four groups: (1) Dark-colored prairie soils, (2) Light-colored prairie soils, (3) Marshy and semi-marshy soils, and (4) Alluvial soils. The dark-colored prairie soils have black to dark-brown topsoils and heavy black to gray subsoils, classified as Lake Charles soils. They are the most extensive and productive soils of the prairie. The light-colored prairie soils, which occur mainly at the interior margin of the prairie, in general have sandy topsoils which rest sharply on heavy, dense subsoils. They are not as fertile as the dark-colored soils. The marshy soils occur as strips of lowland along the Gulf. They are covered with salt- and water-tolerant plants, especially salt grass, *Spartina spartinea,* which is used for winter grazing.

Some of the soils in the area are deficient in phosphorus, as shown by the results of experiments with fertilizers on field crops at the Angleton Station. Other work has shown that the deficiency of phosphorus as reflected in the low phosphorus content of the pasture herbage is conducive to a pathological condition in cattle, known as creeps. The feeding of bone meal usually prevents the development of the disease.

As mentioned previously, the Gulf Coast Prairie is a vast area of natural grassland. On account of the flat topography, resulting in inadequate drainage, together with a heavy rainfall, much of the land

remains wet too long after rains for the successful production of tilled crops, especially in the eastern part of the area. The region, however, is well adapted to cattle raising, which constitutes the principal agricultural industry.

According to the 1935 Census, approximately 71 per cent of the farm land of the region was in permanent pastures which support one of the densest populations, about 8 acres per animal unit, of range cattle in the United States. Twelve counties lying almost entirely within the area, which comprises only 4.1 per cent of the area of the State, had 9.3 per cent of the cattle of the State, or about 675,000 head in 1935. The cattle as a whole are of lower grade than cattle of the western range breeding areas and are of mixed breeding, with a large percentage having Brahman blood. Pure-bred bulls of both the Brahman and British breeds have been used more extensively in recent years than formerly in efforts to improve the type of the very hardy native cattle which are found in this region of heavy rainfall and coarse grasses. The winter maintenance of cattle is a problem in the area, since the prairie grasses become less nutritious after frost and rot rather than cure during the winter. Sudden blizzards, or periods of freezing weather with strong north winds, may occur occasionally in the winter months. During these blizzards, especially when they are accompanied by rains, many cattle on the open prairie may die from exposure and lack of feed. These cold periods are especially severe when the rain freezes as it falls and produces a thin coat of ice on the ground and vegetation, making it difficult for the cattle to secure feed. Usually, however, cattle are moved in the early winter from the prairie to timbered areas along streams where fairly good grazing and protection from the blizzards are found. Some cattle also are wintered on salt grass which occurs on the marshy areas, or salt flats, bordering the coast. Since there is no natural shelter from blizzards on these salt flats, some of the cattle on the flats may die as a result of exposure from sudden and prolonged blizzards.

The dominant native grasses of the prairies are the bluestems or beard grasses. Little bluestem, *Andropogon scoparius,* is the most abundant, although big bluestem, *Andropogon furcatus,* and bushy bluestem, *Andropogon glomeratus,* occur. Other grasses which supply good grazing are *Paspalum floridanum,* yellow foxtail, and several species of Panicum, notably *Panicum virgatum.* With an increase in number of cattle and heavy stocking, the stands of Andropogons have been reduced and other plants, many of which are undesirable, have come into the pastures. Introduced desirable grasses such as Bermuda, carpet, and Dallis grasses may be found in most pastures and are the chief grasses being used for pasture improvement in the area.

The burning of prairie pastures in the late fall or early winter has been a common practice in some parts of the region. The purpose is to destroy the mature dried vegetation in order that livestock can have ready access to the first green vegetation in the spring. Where a pasture is mowed to control weeds and keep the pasture grasses in a young and succulent growing condition, there will be no need to destroy mature growth by

burning. Moreover, if the pasture grasses are properly utilized by the livestock there should not be sufficient dried vegetation in the fall or winter to make a good prairie fire. Since burning is usually done after the annual weeds in the pasture have seeded, it can have little effect in controlling them; but on the other hand the burning often injures the roots of perennial pasture grass, resulting in a thinning of their stand and consequently favoring the growth of annual weeds the following spring. Burning is especially injurious to perennial grass stands if the ground is dry so that the vegetation is burned to the ground. Therefore, the burning of prairie grass pastures cannot be recommended.

Burning over salt grass flats in the late summer in order to obtain young and more succulent growth for grazing in the winter is commonly practiced. The young growth is more nutritious and burning appears to have little or no effect on the stand of salt grass. Since salt grass is not utilized to any great extent as a summer pasture and since weeds are not a serious problem in a salt grass pasture, late summer or early fall burning is beneficial and results in a better winter pasture.

The Gulf Coastal Prairie is one of the major wild life producing areas in Texas and the future existence of the Attwater prairie chicken rests with the land owners of this region, for the species is found nowhere else in the world. The prairies and rice fields are a stronghold for waterfowl, particularly in winter. Bobwhite quail are abundant wherever conditions are favorable and the feed resources substantial. Continuation of the present practice of burning may soon exterminate these phases of wild life.

OBJECT AND SCOPE OF WORK

The objectives of the study were to determine the chemical composition, including mineral content, of the forage plants in native and improved pastures, and to compare native and improved pastures as to carrying capacity and the gain produced on steers. It was recognized before the beginning of the work (Texas Station Bulletin No. 344, "Feeding Bone Meal to Range Cattle on the Coastal Plains of Texas") that there was evidence that the native pasturage is deficient in protein and in certain minerals, and that these deficiencies materially affect the health, growth, and development of livestock in the region. The work was undertaken to answer the question as to whether improved pastures and pasture plants would remove or partially remove these deficiencies. It was believed that pasturage could be so improved as to increase livestock production and improve the quality of livestock in the region. The problems were studied by collecting samples of the principal forage plants for chemical analyses, including mineral content, and by grazing comparable groups of steers on equal acreages of native and improved pasturage.

In addition to the work on pastures, extensive studies have been conducted with various forage and pasture plants at Substation No. 3, Angleton, during the last 25 years. Since the work on forage plants naturally has a bearing on the pasture studies, the results of the studies on forage plants are discussed along with those of the pasture investigation.

This bulletin, therefore, includes pertinent information on forage and pasture plants as well as information on the specific pasture investigations.

FORAGE AND PASTURE PLANTS GROWN AT ANGLETON

As indicated previously, trials with various forage and pasture plants have been made at Substation No. 3, Angleton, since it was established in 1909. A large number of plants have been tested to determine their value for both hay and pasture in the Gulf Coast Prairie. Many of these have come from various parts of the world and have been obtained through the cooperation of the Bureau of Plant Industry, United States Department of Agriculture. Some of the best pasture grasses of the South, as Bermuda, carpet, and Dallis grasses, are introduced grasses. A brief description of some of the more promising introduced grasses and of the more important native grasses is given here.

Andropogons or Beard Grasses

Several of the species of Andropogons are native to the prairie regions of the United States and extend from Texas into Canada and eastward to the Atlantic Ocean. They are the most important constituent of wild or prairie hay. The feeding value of prairie hay in the drier or more northern part of the United States is higher than that of the hay from the Gulf Coast Prairie. This is probably due to the environmental conditions, including soil and climatic conditions.

Little bluestem, *Andropogon scoparius*, is the most common native prairie grass. It is also known as broom-sedge and prairie beard grass. It has a green stem which often has a purplish tinge, and hence the name bluestem. The plant reaches a height of 2 to 4 feet, rarely reaching 5 feet. This grass is the principal constituent of South Texas prairie hay and often occurs in almost solid stands where it has been cut for hay over a number of years. Usually two cuttings of prairie hay are made each year, one in the late spring or early summer and one in the late fall. At the Angleton Station a yield of over 3 tons of hay per acre was obtained in 1936. In commercial hay meadows the yield rarely is more than 2 tons per acre and perhaps the average yield is 1¼ to 1½ tons. If weather conditions are favorable a good quality of hay can be made when the grass is cut before maturity, but a large portion of the South Texas prairie hay is cut when there is a profitable market for it, regardless of the state of growth of the grass. This often results in a poor grade of hay and in much discrimination against South Texas prairie hay.

Little bluestem is one of the most important grasses in the prairie pastures of the region. This grass is very palatable during early stages of growth and is an excellent pasture grass during the spring and early summer. Later in the reason it becomes stemmy and livestock do not thrive as well on it. This grass does not withstand continuous heavy grazing and where the pastures are so grazed it gradually gives way to the sod-forming grasses such as Bermuda and carpet grasses.

Big bluestem, *Andropogon furcatus*, also known as turkey-foot grass, is a native grass and occurs over the Gulf Coast Prairie to a lesser extent than little bluestem. It is distributed over the eastern three-fourths of the United States. This grass reaches a height of 3 to 6 feet. It is not so important as the little bluestem and other than being a taller and coarser grass has about the same characteristics from a hay or pasture standpoint.

Bushy bluestem, *Andropogon glomeratus*, also known as bushy beard grass, is a native of the area and occurs over the southern half of the United States. The culms branch freely toward the top and the inflorescence is dense and feathery, giving it the common name of bushy bluestem. Where this grass occurs in large quantities on prairie hay meadows and has reached the blooming stage, it results in stemmy hay and buyers discriminate against it. Bushy bluestem is not considered as valuable as little bluestem for pasture purposes and is more readily eliminated by close grazing.

Angleton grass, *Andropogon annulatus*, was introduced into the United States from India, its native home. This grass was first grown at the Angleton Station in 1915, from which it took its name, and was received from the Office of Forage Crop Investigations, United States Department of Agriculture. It reaches a height of 2 to 3.5 feet and appears to be particularly adapted to the heavy clay soils of the Gulf Coast Prairie where the rainfall exceeds 30 inches. It survives the winters where the temperature does not fall much below 10 degrees F. It has been killed by a temperature of zero degrees Fahrenheit.

Angleton grass is propagated from the seed in India, but the seed are of such low viability at Angleton that the grass is propagated from the roots entirely. The cost of setting out the grass has been one of the chief drawbacks in getting it into general use. It spreads readily from above-ground runners and is easily eradicated. When allowed to grow for hay it makes an upright growth of fine stems and makes an excellent quality of hay if not allowed to become stemmy. Average yields of over 4 tons per acre in three cuttings have been obtained at Angleton over a period of years. Where Angleton grass is pastured it makes a low growth and the stems creep along the top of the ground. Livestock are very fond of this grass, both as pasturage and as hay, and prefer it to other grasses. Where only small areas are sodded to this grass and livestock have access to it, they keep it grazed as closely as possible, regardless of the amount and palatability of other grasses available. Hogs will soon root up and kill a patch of it.

Andropogon ischaemum (Yellow Beard Grass). Until recently this grass had no common name. It is a native of Central India, introduced here by the United States Department of Agriculture. It is essentially a clump grass but the clumps grow so closely it resembles a turf-forming grass. The fine, tender leaves are relished by livestock. The plant rarely reaches a height of over 8 inches but the seed stems shoot up another 10 inches. It spreads readily by seed and is able to compete successfully with Bermuda

or other grasses. This grass has been grazed in a pasture at Angleton for four years and appears to be a valuable pasture grass. Its yield or feed value has not been determined.

Paspalums

Several species of paspalum occur in the Gulf Coast Prairie, and some of them are important pasture plants. For the most part they are perennial grasses and furnish some grazing during the winter months. The chief disadvantage of this group of grasses is that an ergot or fungous organism grows in the seed heads. When eaten by livestock this diseased seedhead is toxic and may result in a disease known as ergot poisoning.

Dallis grass, *Paspalum dilatatum*, is a native of South America and was introduced into the United States shortly after the Civil War. It is found from Texas eastward to the Atlantic Coast and north to New Jersey. It is a bunch grass and reaches a height of 1 to 4 feet. The grass is progagated from seed which often have a very low germination. Better stands have been obtained from fall seeding than from spring seeding at Angleton. Dallis grass will grow more nearly the entire year than any other grass so far tested at Angleton. Grazing tests indicate that it is one of the most palatable and nutritious grasses adapted to the area. It is admirably suited to the heavy soils and ample rainfall and grows well with other grasses and clovers in a permanent pasture, and withstands heavy grazing. This grass is recommended in any mixture for permanent pasture in the Gulf Coast Prairie.

Bahia grass, *Paspalum notatum*, is a native of the West Indies and South America. This grass has become popular as a pasture grass in Florida and is found in Louisiana and Texas. A large pasture near Bay City has a heavy sod of this grass and it is considered one of the best pastures in the vicinity. It is said to have been introduced by a detachment of cavalry of Union soldiers who were sent to Texas by boat around Florida. The boat stopped at Havana, Cuba, and took on a supply of hay which contained seed of Bahia grass. This grass is found along the Texas Coast wherever this hay was fed.

Bahia grass forms a dense turf and reaches a height of 6 to 24 inches. In Mississippi it is said to be too coarse and livestock do not relish it. But it is considered a valuable pasture grass in Texas. It is spreading naturally on the Angleton Station and is well grazed wherever it appears in the pasture. Bahia grass is aggressive and often has a tendency to crowd out other grasses. The chief source of seed at this time is Cuba and the seed are often low in germination. Some seed are available from Florida and larger local supplies should be available in a few years.

Combs Paspalum, *Paspalum almum*, was first found in Jefferson County, Texas, by J. F. Combs, in 1929. It is also recorded from Brazil, Paraguay, and Argentina. Combs Paspalum reaches a height of 12 to 20 inches and is a fine-leaved bunch grass. It has made a very good growth at the Angleton Station and is considered one of the best pasture grasses

in Jefferson County, where it has been under observation for several years. The grass withstands trampling and deserves further trial in the region.

Long tom, *Paspalum lividum*, is found through the Gulf Coast Prairie of the United States and Mexico and south to Argentina. This grass reaches a height of 1 to 3 feet, but often makes runners 4 to 6 feet long. It roots readily from the joints and is therefore difficult to eradicate from cultivated fields, especially during wet seasons. It prefers low wet ground and in parts of the Gulf Coast Prairie of Texas is a pest in cultivated fields, notably near Port Lavaca. It is found in abundance in old rice fields and along ditches. It furnishes some grazing and is an excellent soil binder, in which capacity it is used at the Angleton Station.

Georgia Paspalum, *Paspalum plicatulum*, sometimes known locally as honeydew grass, is found from Texas to Georgia and Florida and south to Argentina. This grass reaches a height of 1½ to 3 feet. It is abundant in many of the meadows and pastures of the area and furnishes a considerable amount of grazing in the spring months.

Other Important Grasses

Bermuda grass, *Cynodon dactylon*, is a native of India and other parts of the Old World. It was introduced into the United States in the early days, and while the date has not been definitely established, it was recorded as early as 1807. It is found throughout the cotton belt where it is often considered a native grass by stockmen and farmers. Bermuda grass grows to a height of 4 to 6 inches, although on rich alluvial lands it may reach a height of 12 to 18 inches, making a good hay plant.

Bermuda grass is a very vigorous grower and will succeed on almost any type of land. It spreads mainly by rootstocks, which may be either above ground or under ground. The seed produced in the Gulf Coast Prairie have a very low germination, but the grass probably spreads to some extent by seed. Where livestock have access to a Bermuda grass pasture, the manure may contain enough viable seed to infest clean fields. Bermuda grass generally is propagated by rootstocks, but seeding may be cheaper under favorable conditions. The seed usually are obtained from Australia or the dry irrigated sections of the United States, chiefly Arizona. The germination of the seed is slow, and during recent years seedsmen have been offering de-hulled seed, which germinate very rapidly. At the Angleton Station fall or winter seeding of the unhulled seed has given good results. Where the de-hulled seed are used, however, planting should be delayed until early spring, for the seed germinate readily and the young seedlings may be killed by frost.

Bermuda grass survives the winter in the cotton belt and has been known to withstand a temperature of —14° F. When the tops are allowed to become too mature, they become tough and wiry and are not relished by livestock. For this reason the grass makes better pasturage when closely grazed. Bermuda grass grows well in mixture with bunch grasses and lespedeza. It is one of the few grasses that produced a higher yield

of forage at Angleton when clipped monthly than when allowed to grow to maturity before harvesting.

Giant Bermuda grasses, *Cynodon barberi* and a robust form of *Cynodon dactylon*, have been grown under pasture conditions at the Angleton Station with little success. They succeeded well in pure stands but could not compete with the common Bermuda or other grasses in a mixture.

Carpet grass, *Axonopus compressus*, is a native of tropical America and possibly of Florida. It is a perennial with creeping rootstocks and rarely reaches a height of 2 feet. It is found along the Gulf Coast Prairie and is present in most pastures of the region. Carpet grass thrives best where there is ample moisture and will usually be found most abundantly where water stands occasionally. This grass furnishes grazing from early spring to killing frost in the fall; and where a heavy growth has occurred during a wet fall, frost may kill the tips but leave the blades still green nearer the ground. This valuable characteristic of carpet grass is not so well known as it should be.

Carpet grass grows readily from the seed, which are comparatively cheap. It can be propagated by the runners, but most pastures in the area contain sufficient carpet grass to form a sod if given a chance to spread. Carpet grass is not as palatable as Angleton or Dallis grass but is readily eaten when it is the only grass present. Where it is grown in mixtures the preference of the animals for other grasses often permits carpet grass to grow up and form a valuable source of green feed for winter grazing. One disadvantage of carpet grass is that it is so aggressive it has a tendency to crowd out other grasses, especially on the low, moist places in the pasture. At Angleton cattle seem to relish carpet grass more when it is partly submerged after heavy rains than when it is dry.

Flat crab grass, *Axonopus furcatus*, is similar to carpet grass but has a coarser growth and is not quite so aggressive. The leaves have more of a yellowish green cast than carpet grass. It is found in small amounts on many pastures of the Gulf Coast Prairie and probably has about the same feeding value as carpet grass.

Salt grass, *Spartina spartinae*, probably more properly called cord grass, is a clump grass that reaches a height of 2 to 4 feet. It grows in almost pure stands in the brackish soils near the Gulf and is found wherever the tide water has reached and on the white or salt spots over the Gulf Coast Prairie. Salt grass is a perennial, and the leaves remain green over the winter. It is not pastured to any extent during the summer because of the mosquitoes and green-headed flies which infest the salt-grass lands and because other more palatable grasses are available on the prairies. It is largely used for winter grazing, a common practice being to burn the salt grass in the fall so that the young leaves are available for the winter. The young leaves are more palatable and much higher in food value than old leaves, according to chemical analysis made by the Texas Agricultural Experiment station. (Table 6)

Minor Pasture Grasses

Smut grass, *Sporobolus poiretii,* a clump grass introduced into America, is found in the southeastern part of the United States and reaches a height of 1½ to 3½ feet. It is present in many pastures, especially on the pastures that have been overgrazed for a period of years. It is not very palatable and livestock graze it only when other more palatable grasses are lacking.

Centipede grass, *Eremochloa ophiuroides,* a native of Southeastern Asia, is a low perennial reaching a height of 2 to 4 inches and spreading by thick leafy stolons. Centipede grass has become popular in parts of Florida and Mississippi as a lawn and also a pasture grass. Its low growth makes it of doubtful value as a pasture grass in the Gulf Coast Prairie of Texas except possibly on alluvial soils. At Angleton this grass hardly reaches a height where cattle could graze it successfully.

St. Augustine grass, *Stenotaphrun secundatum,* is a creeping perennial grass that reaches a height of 4 to 12 inches and makes a good lawn grass on rich alluvial soils where it receives an abundant supply of moisture. It will stand partial shading. St. Augustine grass probably would make a fair pasture grass under the above conditions, but on the prairie soils it cannot compete with other vegetation and the long dry periods during the summer thin it considerably. Its yield under pasture conditions at Angleton is very low.

Crab grass, *Digitaria sanguinalis,* a native of Europe, is a pest in cultivated fields throughout the United States at low altitudes. It reaches a height of 1 to 3 feet and makes a good forage. It often occurs on newly seeded pastures and is a valuable nurse grass for the other grasses. It will not stand heavy grazing and will give way to the other grasses as they spread in the pasture. Crab grass furnishes good pasturage in many cultivated fields in the South during the fall after the crops have been harvested and until frost.

Annual bluegrass, *Poa annua,* is found throughout North America and is a native of Europe. It reaches a height of 2 to 7 inches and grows through mild winters at Angleton. It is a pest in winter gardens. Its short growth makes its value as a pasture plant doubtful, but livestock graze it during the winter and early spring whenever it reaches sufficient height. This grass grows on richer well-drained lands and especially around barnyards and farmsteads.

Para grass, *Panicum purpurascens,* is a tropical grass that has been introduced into the Gulf States. It reaches a height of 3 to 6 feet, makes long thick runners that root at the joints. Para grass will grow in the edge of water and is cultivated in the tropics for green forage. It will not stand heavy grazing but livestock relish the grass and it has made good yields at the Angleton Station. This grass can be grown on low ground that is subject to overflow. Under these conditions it would be valuable as an emergency pasture when other pasture was not available, but it probably would not withstand continuous pasturing.

Gama grass, *Tripsacum dactyloides,* is a native of the eastern half of the United States. This grass is one of the few close relatives of corn, *Zea mays,* and has been crossed with it by Dr. P. C. Mangelsdorf and Dr. R. G. Reeves, of the Texas Station. Gama grass reaches a height of 3 to 6 feet and is quite common in the Gulf Coast Prairie, especially along railroads, in hay meadows, and in the edges of cultivated fields which are not accessible to livestock. This grass is palatable but will not withstand heavy grazing.

Grama grass, *Bouteloua gracilis,* or blue grama, is a native of the ranges in the western states, where it is considered a valuable grazing grass and reaches a height of 6 to 24 inches. It is found on alluvial soils along the streams in the Gulf Coast Prairie. On Oyster Creek near Angleton, it is found in almost pure stands in some pastures, especially on old cleared fields that have been turned into pastures, where it is considered a valuable pasture grass.

Grasses for Temporary Pasture

Sudan grass, *Sorghum vulgare, Var. sudanense,* is a tall-growing annual grass that is excellent for hay and summer pasture. Its value as a grazing crop is recognized in the drier parts of the United States. It can be grown broadcast or in drills and when drilled, can be grown in alternating rows with cowpeas, soybeans, or other legumes for grazing. When permanent pastures become short from unfavorable weather conditions, Sudan grass may be used to furnish grazing until the pastures recover. Where the crop is not needed for grazing it can be made into hay or silage. In the humid Gulf Coast Prairie Sudan grass hay should be stacked for two weeks or more before it is baled, otherwise it may heat and mold. This precaution is not necessary in drier parts of the State.

Johnson grass, *Sorghum vulgare,* is a pest in many cultivated fields in the Gulf Coast Prairie and other parts of Texas. It furnishes good grazing during the fall after the crops are harvested. When grazed continuously Johnson grass is a poor pasture grass. It soon makes very little growth and heavy pasturing is one easy way to bring this grass under control. An occasional cultivation of the land is necessary to keep Johnson grass growing luxuriantly.

Rhodes grass, *Chloris gayana,* is a native of Africa and succeeds where the rainfall is not too heavy and where the winters are not too severe. It does best where the average yearly rainfall is 20 to 35 inches and the temperature rarely drops below 20° F. At Angleton, Rhodes grass does well in a cultivated row but under pasture conditions or in a hay meadow it is soon crowded out by more aggressive grasses.

Legumes

A number of varieties of legumes have been grown under pasture conditions at the Angleton Station. Considerable difficulty is often encountered in getting winter clovers to grow on the prairie pastures. Clovers

grow luxuriantly in pastures on the alluvial land and often form such a high proportion of the herbage in the early spring that they may cause severe scouring in cattle unless grass hays are fed.

On prairie lands, good drainage, inoculation, and at least moderate fertility of the soil are necessary to get clovers established. After the clovers have once started making good growth, little difficulty will be experienced in maintaining them in the pastures if they are not overgrazed. During occasional cold winters the clovers will make little growth and may be killed, but sufficient hard seed remain in the soil to give a fair stand again in a few years.

A large number of clovers and other legumes have been grown at the Angleton Station during the last ten years. Some of those better adapted for pastures on prairie soils will be discussed.

California bur clover, *Medicago hispida*, has proved to be one of the best pasture clovers for this section. It makes a rank growth and although livestock do not relish it at first, they soon become accustomed to it and eat it readily. During mild winters it furnishes far more pasturage than any other clover in the region but appears to freeze more easily than some other clovers. It should be in every permanent pasture in the Gulf Coast Prairie.

Early southern bur or spotted-leaf bur clover, *Medicago arabica*, makes a good growth in the Gulf Coast Prairie but does not grow as luxuriantly as California bur clover. Since both grow under similar conditions, California bur clover is preferred.

White Dutch clover is a short clover but it is relished by livestock. It is found widespread over the area and next to California bur clover is the most important pasture clover. It can withstand more cold weather than the bur clovers, but makes less forage under favorable conditions.

Persian clover has made a good growth at Angleton, is persistent, and combines well with White Dutch clover. In fact it is difficult to get Persian clover seed without some White Dutch clover in it. This clover could very well be in any pasture that will grow White Dutch clover.

Subterranean clover is one of the highest-yielding clovers on cultivated land. It is relished by livestock but the seed are expensive and this clover will not maintain itself under pasture conditions. For this reason it is not recommended for pastures.

Hop clover and black medic have been grown on cultivated land and in pastures at the Angleton Station. They have made very poor growth under both conditions and cannot be recommended. On more fertile soils these clovers might succeed.

Yellow annual sweet clover, *Melilotus indica*, makes a good growth during mild winters and is one of the best green-manure crops for the Gulf Coast Prairie. It grows well under pasture conditions but is not relished by livestock when other clovers or grasses are available. However, when the yellow annual sweet clover matures, seeds and the leaves fall; then livestock seem to relish the dried stems and will graze on them very readily. Although this clover may add to the fertility of the soil

of the pasture and furnish some forage when mature, its value for pasture is problematical and if other better clovers can be grown, its inclusion is not to be recommended.

Wild vetch is found in a number of pastures in this area. It succeeds well in a mild winter, although cattle give it very little chance to make much growth. It succeeds best where cattle do not have access to it at all times. Hairy, purple, and Oregon vetches do well on cultivated lands and would be excellent for temporary spring pastures but have not been grown successfully on sod land at the Angleton Station.

Lespedeza is one of the essential legumes for Gulf Coast pastures. Most of the lespedezas are annual summer-growing legumes and will reseed from year to year. They add protein to the summer forage when most other legumes are not growing. The lespedezas will spread if the grasses are kept short but will be shaded out by heavy growth of weeds or tall grasses. The common, or Japan, lespedeza makes a shorter growth than the other types but will maintain itself better and is to be preferred to other varieties. Kobe, Korean, and Tennessee 76 lespedezas are taller and earlier varieties developed for more northern conditions. Here they often mature a seed crop in the late summer. These seed may germinate in the fall and the young seedlings may be killed by frost before they have a chance to produce seed. Under these conditions they may be killed out of the pasture. They make higher yields on cultivated land than the common lespedeza.

Lespedeza sericea, a perennial lespedeza, has been grown at this station and although it makes some growth, it must be cultivated in order to keep the summer grasses from crowding it out. It has made little or no growth under pasture conditions.

Inoculation of Legumes

When leguminous plants—as alfalfa, beans, clovers, cowpeas, lespedeza, soybeans, and vetches—have nodules on their roots caused by certain bacteria, they are said to be inoculated. The nodules, which are small bead-like growths on the roots, are formed by bacteria which live in the nodules. These bacteria have the power of taking the free nitrogen from the air and combining it into a form that is used in the growth of the legumes. Commercial cultures containing the proper bacteria for different kinds of legumes are now on the market. The application of these cultures to legume seed is called inoculation.

If the bacteria are not present the legumes will not fix the free nitrogen of the air. If it is known that the soil does not contain the proper bacteria or if the soil has not grown the particular legume before, the soil should be inoculated with the proper bacteria. Probably the best and easiest way of inoculating is to buy commercial cultures of the right kind of bacteria and mix with the seed. Different kinds of legumes require different strains of bacteria and the proper strain should be obtained for the seed to be planted. The soil also may be inoculated by spreading soil from a field that has grown inoculated legumes.

IMPROVEMENT OF PASTURES

Drainage

The smooth topography and the heavy semi-permeable soils of the Gulf Coast Prairie result in slow and inadequate drainage on the surface and through the soil. Since water does not percolate readily through the soil, surface drainage by means of ditches is the most practical method of drainage. Accordingly, surface drainage systems, including large main ditches and some lateral ditches, have been constructed in most parts of the region. These ditches have improved the drainage materially, but apparently a more complete system, especially more small surface ditches, is needed in places.

Good drainage is one of the most important factors to be considered in improving pastures in the area. Many of the better grasses and most of the adapted legumes require fairly well-drained soil for best growth. Usually they do not grow where water stands for long periods after rains. Wherever practical, such places may be drained to advantage.

Many small ponds are found which serve as breeding places for many types of parasites. The fresh water snails, secondary host of the liver fluke which is one of the most common and most injurious internal parasites of cattle in the region, often abound in and adjacent to such ponds. These permanent ponds should be treated to kill the parasites, or drained, or if they are desired as a harbor for waterfowl or other game, livestock should be excluded from them by fencing. If this were done, the degree of parasitic infestation of the cattle could probably be reduced.

Mowing

Weeds or worthless vegetation can be destroyed by systematic mowing, which results in increased carrying capacity of the pasture and a more even distribution of feed throughout the year. Two of the factors which operate to produce poor pasturage and consequent low gains during the summer and fall are: First, the early maturity of the native pasture grasses which are mostly bluestems; and, second, the growth of weeds which reach a sufficient height to shade out the lower-growing grasses and to compete strongly for plant food and moisture. Mowing tends to correct both factors in that it helps to destroy the weeds and removes the mature growth of grass so that the plants send out new and more succulent growth.

The mowing should be so timed as to do the maximum amount of damage to the plants to be destroyed. Usually this will occur when the plants are just beginning to bloom, for at that time their energies are directed to the production of seed. If the mowing is delayed after many of the plants are in bloom, viable seed may mature after the plants are cut and thus re-infest the pasture. The first cutting should be made as high as the cutter bar of the mower can be set and still cut off all of the seed heads so that the succeeding growth of seed heads can be reached

by the next mowing. When growing conditions are very favorable, a third mowing may be necessary the first year that the pasture is mowed; but, as a rule, two mowings will be sufficient. About three years of mowing will usually destroy most of the weeds and thereafter one mowing will suffice for control. It is to be noted, however, that some weeds not important at first become numerous when most of the others are destroyed. The time of mowing should then be changed to control these weeds. An example of this type of weed in the Gulf Coast Prairie is a spring legume called buttonbush which seeds before the first mowing for the control of summer weeds. Although this plant is a perennial and early spring mowing may not destroy it, the practice will prevent its spread.

Since some of the native weeds are important game foods, and in addition provide cover, the elimination of weeds by mowing may necessarily conflict with a program for the preservation of wild life. Mowing during the nesting season of quail and prairie chicken may also result in the loss of the young. However, when a grass sod has been established and mowing is done only to even up the growth of grasses, it may deferred until after the nesting season.

Seeding Desirable Pasture Plants

Pasture grasses and clovers can be seeded on a well-prepared seed bed, on old cultivated land or pasture land and disked in, or they may be sown on the pasture without any attempt to cover them, relying on subsequent rainfall to produce germination. Any of these methods will be successful under some conditions and unsuccessful under other conditions. Seeding a pasture to improved grasses or clovers, without providing soil conditions favorable for plant growth, will be largely a waste of effort. Many of the native pastures of the Gulf Coast Prairie contain some carpet, Bermuda, or Dallis grass, some lespedeza, and perhaps some clovers. If the conditions in the pasture are such that these valuable plants are not spreading, seeding them will usually be found to be of little or no value.

There are five conditions that may prevent the establishment or spread of desirable pasture plants—(1) shading, (2) poor drainage, (3) lack of soil fertility, (4) crowding by worthless tall, coarse grasses or weeds, and (5) grazing before plants become established. Mowing, which has been discussed previously, and in some cases plowing, will help prevent shading and crowding. Poor drainage may result in such a weak growth of the desirable plants, especially legumes, that they cannot withstand grazing or may be easily crowded out by other vegetation. If the soil fertility is too low to enable the grasses or clovers to become established, some attention should be given to building up the fertility of the soil before pasture plants are seeded. Grazing before the plants have become established is an easy way to kill out the seeded pasture plants, and must be avoided.

In making a seed bed for grasses and clovers, the land should be prepared sufficiently in advance of the time of planting to allow for at least

one soaking rain. Grass seedlings are usually weak soon after germination and if the seed bed is firm and moist the young seedlings will not die from lack of moisture. If, however, the seed bed is loose, a heavy rain following seeding may cover many of the seed too deeply. Covering the seed lightly with a harrow after planting on a firm, well-prepared seed bed is always desirable.

On sod or old cultivated land, disking the land lightly to cover the seed has been successful. Sowing legume seed mixed with barnyard manure has resulted in good stands. The manure acts as a fertilizer to give the seedlings a good start and discourages early grazing by livestock, thus giving the plants a chance to produce seed.

All clovers except lespedeza should be planted in the fall, since they make maximum growth in the late winter and early spring and reseed in the spring. The lespedezas should be planted not later than February, although plantings made in November and December have given good results at Angleton. Better stands of carpet grass, Bermuda grass, and Dallis grass have been obtained by late fall or early winter seeding than by late winter or early spring seeding on prepared seed beds and on sod land at Angleton. Where the seed are planted in the late fall or early winter the long weathering period seems to make the seed coat more permeable to water, thus giving a higher rate of germination. As soon as the weather warms up in the late winter or early spring, the plants emerge and become established before hot or dry weather destroys them. Dry periods in April or May are very common in the Gulf Coast Prairie and are injurious to grass seedlings that are just emerging. Late fall or early winter planting usually results in stands by late February and the seedlings are established by April. The danger in this method of planting lies in the loss of plants by late severe freezes. This danger, however, is not nearly so great as the loss of later planting from dry, hot weather.

In general the high cost of grass seed together with the comparatively low germination makes it undesirable to seed heavy enough to get a good stand the first year. Usually it is better to seed the entire area the first year with a few seed than to seed small areas heavily each year until the entire area is seeded. In this way the grasses will be more or less introduced into the pasture from seeding, and then the sod will be obtained by reseeding or spreading from runners. The seeding rate may be 2 to 10 pounds per acre, or even heavier. The first thin seeding should result in a good sod or stand in two years if conditions are favorable. Where mixtures are planted a more uniform stand will be obtained by planting each type of seed separately unless the seed are similar in size, shape, and weight. Dallis grass seed should always be seeded separately, since they are large and light and do not mix well with other seed for sowing. They should be seeded slightly heavier than Bermuda grass and carpet grass. Hand broadcast seeders are inexpensive and are satisfactory for sowing most grass and clover seed except during windy periods when the distribution of the seed may not be uniform.

The seeding rate of clover may be varied from 1 to 10 pounds per acre. In seeding lespedeza on a prepared seed bed with other pasture plants, 2 to 4 pounds per acre is sufficient, for the seed germinate well and the seedlings grow off rapidly. A thick stand of young lespedeza plants may choke out or thin out young grass seedlings that are just emerging and growing.

GRAZING EXPERIMENTS ON IMPROVED AND UNIMPROVED PASTURES

Establishing Pastures

The improved pasture used in these grazing studies was established in 1931, 1932, and 1933. In the late summer of 1930 an area of 17½ acres in native unimproved pasture was plowed and a good seed bed prepared. In May, 1931, it was divided into seven areas of two and one-half acres each. One of the areas was sodded to Angleton grass; one was seeded to Bermuda grass; one to carpet grass; one to Dallis grass; and one to Bahia grass; one was seeded to a mixture of Dallis, carpet, and Bermuda grasses; and another to a mixture of Bahia, carpet, and Bermuda grasses. In addition to these plantings Japan lespedeza was seeded on one-half of each of the seven areas on the same date. On account of dry weather these plantings were a failure. These areas, except those planted to Angleton and Bahia grasses, were seeded again late in 1931 and an excellent stand of plants obtained. The Bermuda and carpet grasses were seeded at the rate of 10 pounds per acre and Dallis grass at the rate of 15 pounds. Where the mixture was planted each grass was used in proportion; that is, where three grasses were planted, each was sown at one-third the rate of seeding when planted alone. All seed were harrowed in after sowing. On the area sodded to Angleton grass only a few scattered plants were obtained but no further attempt was made to establish the grass. This area contained some volunteer growth consisting mostly of carpet, Bermuda, and crab grasses. The area originally seeded to Bahia grass was not seeded again and the vegetation consisted entirely of these volunteer grasses. This improved pasture of 17½ acres was mowed twice each year in 1932 and 1933. The steers in Group I, mentioned later, were grazed on this pasture from April 19, 1934, to November 15, 1937, a period of 1305 days.

In addition to the improved pasture just mentioned, another area of 12 acres of native pasture was improved by mowing only. The area was mowed first in June 1930. By midsummer mowing had improved the pasture to such an extent that the cattle much preferred grazing on it to grazing on the adjoining areas that were not mowed. This pasture was mowed again in the fall of 1930, and twice in 1931, 1932, and 1933. During the four years mowing produced a good sod. Although this improved pasture was developed along with the improved seeded pastures discussed in the preceding paragraph, it was not used in the grazing experiments discussed later.

The third area was a part of the pasture which had not been improved. The grasses on this pasture were mostly little bluestem with some big bluestem, some bushy bluestem, and small amounts of carpet grass, Bermuda grass, and Dallis grass. There was also considerable growth of weeds consisting of myrtle brush, sulphur or ragweeds, milkweed, bitterweed, and a species of wild sunflower. This pasture carried the steers in Group II from April 19, 1934 to June 16, 1937, or a period of 1154 days.

Although the pasture that was improved by mowing only was not used in the grazing trial to be discussed presently, it was grazed by other livestock and a comparison of this pasture with the seeded pasture shows some striking differences. It required two years to obtain a good sod, or sward, on the seeded pasture and four years on the mowed pasture. It was necessary, however, to mow the seeded pastures occasionally to control weeds. The seeded pasture contained more kinds of grasses in a more uniform mixture than the mowed pasture. The flora of the latter pasture was changed markedly by mowing twice a year. The tall-growing bluestem grasses soon gave way to the lower-growing pasture grasses such as carpet and Bermuda, and the weeds were soon reduced to a comparatively minor factor. The few scattered plants of carpet and Bermuda grasses began spreading and by the third year were occupying extensive areas in almost solid stands. The carpet grass was more aggressive than the Bermuda grass and occupied a much larger part of the area. During the first two years of mowing there were considerable amounts of bare areas of soil among the bluestem grasses. By the third year there were very few of these bare areas, and by the fourth year they had disappeared. Where present, lespedeza began spreading as soon as the mowing was started and by the fourth year occupied extensive areas together with the carpet and Bermuda grasses. On the wet areas in the mowed pasture the carpet grass crowded out almost all other vegetation.

Results of a Grazing Trial with Steers on Improved and Unimproved Pastures

A grazing trial with 14 steers was conducted from 1934 to 1937 on the improved and the unimproved pastures just mentioned. The steers were yearlings when bought in Brazos County and delivered by truck to Angleton, April 18, 1934. They were of beef breeding but were wild and plain to medium in grade. They were weighed singly at College Station and as weighed were divided as equally as possible into two groups of seven. Group I, by chance, was placed on the improved (seeded and mowed) pasture and Group II on the native pasture. Both groups had access to sheds open on the south. The steers were on trial from April 19, 1934, to November 15, 1937, a period of 1305 days. The data obtained from the grazing trial are shown in Table 1, and since the station did not have livestock scales, no weights were obtained except the initial weight at College Station and the final weights at the Houston market.

Both pastures had one steer to each 2.5 acres. The improved pasture supplied an ample quantity of forage during the 3 years and 7 months

which it was grazed and during the summer of 1934 yielded 3.5 tons (mostly carpet grass) of hay. The native pasture was pretty well grazed out at the end of 3 years and 2 months and would not have supported the seven steers if it had not been in better than average condition at the beginning. It was necessary to feed some 420 pounds of prairie hay per head to the steers on native pasture during the severe winter of 1934-35, while the steers on improved pasturage were not fed. No supplementary feeds were supplied during the two ensuing mild winters; however, the steers on improved pasture entered and emerged from the winters in much stronger condition than the steers on native pasture.

Table 1. Summary of Grazing Trial, April 19, 1934, to November 15, 1937

	Group 1 Improved pasture	Group II Unimproved pasture
Number of steers	7	7
Acres of pasturage per steer	2.5	2.5
Days of grazing	1305	1154
Average Per Steer		
Initial weight, lbs	485	485
Final weight, lbs. (market)	1010	843
Gain, lbs	525	358
Average daily gain, lbs	0.40	0.31
Carcass weight (hot), lbs	591	478
Carcass grades:		
Low medium	7	3
Common	.....	2
Cutter	.....	2
Dressing percentage (hot weight)	58.5	56.7
Hide weight, lbs	66	59
Hide as a percentage of market weight	6.53	6.98
Selling price, Houston	$ 6.25	$ 6.35
Amount received	63.12	53.51
Cost delivered at $5.04 per cwt	24.46	24.46
Interest on initial cost at 8%	7.00	6.18
Cost of salt and hay	1.00	3.09
Marketing cost	1.43	1.43
Return for grazing	29.23	18.36
Advantage for Group I	10.87	
Gross return per acre per year	$ 4.32	$ 3.68
Net returns per acre per year	3.27	2.31

The steers grazed on the native pasture gained more rapidly during the spring months and shed their winter coats of hair earlier than the steers on the improved pasture. They reached their highest condition in June in each of 2 seasons of grazing. After June they barely maintained their flesh until fall and lost considerable weight during the winters. The group on improved pasture apparently lost less weight during the winters and gained less rapidly in the spring but continued to gain during the summer and fall, attaining their highest condition in October.

In order to give each pasture the benefit of the observed seasonal condition of the steers, the group on native pasturage was marketed in June. Group I, on improved pasturage, should have been marketed in October,

but was not sold until November 17 or after the steers had begun to lose condition. Group I had 151 days more grazing per head, made 167 pounds more gain, had higher dressing percentage, were more desirable in carcass grade, and with a less favorable market sold for nearly as much per pound and returned $10.87 more per head for their grazing. The financial returns from grazing both pastures were satisfactory; for even with the lower market in November, prices were still above those prevailing at the time the steers were purchased as stockers.

A single trial in grazing equal acreages of native and improved pasturage cannot adequately determine the value of improvement but may indicate the value of improvement if the cattle are marketed under similar conditions. On basis of actual sales less costs of marketing, interest, feed supplement, and purchase price, the steers on improved pasturage returned $3.27 per acre per year for the grazing, and the steers on native pasture $2.31, resulting in an advantage of $0.96 per acre per year for improvement. Had both groups of steers been sold at the same date during 1937, Group I would have had an advantage in price of about $2.00 per cwt. and the per acre per year advantage for improvement would have been increased to $3.53, an amount more than sufficient to pay for seeding and mowing.

The better results obtained from grazing the improved mowed pasture are attributed largely to the benefits resulting from mowing, namely, lack of weed competition, and succulent new growth of grasses, with consequent higher content of protein, phosphorus, and calcium during the summer and fall. The improved mowed pasture had greater density and probably made a greater yield of forage on that account, since it was determined that in pure stands the native bluestem grasses made higher yields than the improved grasses when in pure stands. Each group of steers remained in their assigned pasture for the entire time they were kept on the station farm; however, this grazing system was not considered ideal for obtaining the maximum of benefit from both pastures. The performance of the steers and the growth of the grasses indicated that a better system would have been to graze all of the steers on the native pasture during the spring and early summer and then to graze the improved pasture for the remainder of the year.

YIELDS OF FORAGE OF DIFFERENT GRASSES

Yield data on the various pasture grasses were obtained during the growing seasons of 1934 and 1935. An area with similar soil types (Lake Charles clay loam) and a uniform stand of each kind of grass or mixture of grasses was fenced off and divided into two parts. One part was clipped each month during the growing season to get data on yield and chemical composition of the forage. On the other part, samples of the accumulated growth since spring were obtained each month for chemical analysis and at the end of the growing season yield was obtained on the mature grasses. The data obtained give comparative feeding values of monthly clippings as compared with the same grasses during various stages of growth to

maturity. The data also give comparative yields on monthly clippings during the growing season and the same grasses or mixtures when they are allowed to grow to full maturity before harvesting.

The grasses were harvested with a lawn mower and the clippings caught in a grass catcher. Where the grasses were too high, especially in the case of the maturing samples, they were first cut with grass shears and then the remainder was cut with the lawn mower. Green weights were obtained soon after harvesting and the samples then dried in the sun in open mesh bags until they reached a constant weight. After the air-dry weight was obtained, the samples were sent to the Division of Chemistry, at College Station, for chemical analysis. Samples of salt grass were collected from soil on the salt spots in the pasture and from brackish lands near the coast.

The 1934 season was characterized by ample rains in the early spring, no effective rainfall from the second week in May to the second week in July, ample rains the rest of July, August, and September, but a dry October. The 1935 season had a more even distribution of moisture, but there was no effective rainfall from the last week in July to the first week in September. The total effective rainfall in 1934 was 54.92 inches and in 1935 it was 52.87 inches.

Yield of Grasses Clipped Monthly

The yields of forage of the several grasses obtained in 1934 and 1935 are given in Table 2. In 1934, native grass (consisting mainly of little bluestem, big bluestem, and bushy bluestem) and the mixed improved grasses (Bermuda, carpet, and Dallis) made the largest yields, 4534 and 4354 pounds of air-dry forage per acre, respectively, when harvested at monthly intervals. The native grasses also produced the largest average yield in 1935 and also the highest average yield for the two years. Carpet grass made the smallest average yield of forage.

Yield of Grasses Harvested at Maturity

As a group the grasses harvested at maturity produced decidedly larger yields than those harvested at monthly intervals (Table 2). For example, in 1934 the grasses harvested at maturity produced an average yield of 4333 pounds of air-dry forage per acre, which was 1007 pounds, or 30 per cent more than the yield of the grasses harvested at monthly intervals. During the two years, the grasses harvested at maturity made an average yield of 3896 pounds per acre, or about 42 per cent more than the yield of those cut monthly.

Although on the average the grasses harvested in the mature stage produced larger yields than those harvested monthly, all of the grasses did not behave the same with respect to frequency of cuttings. For instance, Angleton grass produced an average yield of 2221 pounds when clipped at monthly intervals and 8016 pounds when harvested at maturity. Clipping, or frequent harvesting, reduced the yield tremendously, indicat-

ing that Angleton grass is probably better adapted for hay production than for pasture. On the other hand, Bermuda grass produced more than twice as much forage when clipped at monthly intervals. Frequent cutting evidently was beneficial and indicates that Bermuda grass should be grazed rather closely for best results, which is in accord with general experience and observation. Frequent cutting with the lawn mower also reduced the yield of carpet grass and Dallis grass to some extent.

Table 2. Yield of air-dry forage of various grasses in 1934 and 1935

Kind of grass	Yield of air-dry forage, pounds per acre					
	Grass clipped monthly			Mature grass		
	1934	1935	Average	1934	1935	Average
Angleton	2244	2197	2221	7275	8756	8016
Bermuda	2917	2253	2585	1669	793	1231
Carpet	2678	1581	2130	4244	1742	2993
Dallis	3227	1944	2586	3093	2603	2848
Mixed improved*	4354	2148	3251	5136	2926	4031
Native†	4534	2784	3659	4601	3913	4257
Average	3326	2151	2730	4333	3456	3896

*Mixture of about equal parts of Bermuda, carpet, and Dallis grasses.
†Largely little bluestem with some big bluestem and some bushy bluestem.

The native grasses made a higher yield of both mature forage and monthly clippings than did the Bermuda grass, carpet grass, and Dallis grass, or a mixture of the three grasses. These yields were obtained on pure stands where there were no weeds and the yields for that reason cannot be considered applicable to pasture conditions where no attempt is made to control weed growth. Where the pasture is mowed regularly to destroy weeds the amount of native bluestem grasses decreases rapidly and carpet and Bermuda grasses soon occupy the land. This presents a problem as to how the native bluestem grasses can be utilized for pasture purposes to take advantage of their high yield and excellent growth during the spring and early summer and at the same time keep the weed growth under control so that the weeds will not greatly reduce the growth of the bluestem grasses.

A possible solution is found in the behavior of the bluestem grasses on the native hay meadows of the region. Where these grasses are cut twice a year for hay, almost complete elimination of the weeds is obtained. This is explained by the fact that the bluestem grasses have an opportunity to make their maximum growth before cutting, thereby crowding and shading out the lower growing grasses such as Bermuda or carpet grass, leaving almost pure stands of the bluestem grasses. If the bluestem grasses are pastured off during the spring and early summer, until the last of May or the first of June, advantage will be taken of the excellent pasturage furnished by these grasses at that time. The livestock could then be moved from the bluestem pasture to the improved pasture and the bluestem pasture mowed to even up the growth and destroy any weeds present. The bluestem grasses could then be allowed to grow the

remainder of the season without pasturing and their heavy growth would discourage the growth of weeds or the lower growing grasses. The bluestem grasses could be cut for hay in the fall, thus providing a source of much needed supplemental feed for the livestock and at the same time leaving a clean pasture that should provide good grazing the following spring. This system of pasture management has not been tried at Angleton for lack of facilities, but it offers a possible solution to several of the pasture and feed problems of the region.

CHEMICAL COMPOSITION OF GRASSES

It is known that the chemical composition of pasture herbage and various other feeding stuffs greatly influences their feeding value. The chemical composition of plants is influenced to some extent by the kind of soil, by fertilizers applied to the soil, and by the age or stage of growth of plants. In order to get some information on the chemical composition of some of the grasses, samples of forage harvested at monthly intervals and at various stages were obtained and analyses made. The complete analytical data are presented in Tables 3, 4, 5, and 6. The data on protein, phosphorus, fat, and calcium, however, are taken out of these large tables and put into smaller tables for convenience of discussion.

The chemical analysis of the grasses was made by the Division of Chemistry.

Protein Content

As will be seen from Table 7, the protein content is influenced by the kind of grass, by the stage of growth, and by the season. As an average of all comparable analyses of samples cut at monthly intervals during the two years, Dallis grass had decidedly the highest protein content, 10.23 per cent. Bermuda grass contained 9.78 per cent; native grasses 9.44 per cent; carpet grass, 9.12 per cent; mixed improved grasses, 8.98 per cent; and Angleton grass, 7.96 per cent. Apparently the differences in protein content do not explain the differences in palatability, for Angleton grass had the lowest protein content and is one of the most palatable grasses. On the other hand Dallis grass is high in protein and is relished by all kinds of livestock.

As a rule the protein content of the grasses harvested each month was nearly constant during the growing season, as shown by the figures in Table 7. On the basis of comparable analyses during the two years, the protein content of the group of grasses as a whole was 9.54 per cent in July, 8.72 per cent in August, 9.76 per cent in September, 9.71 per cent in October, and 9.02 per cent in November.

When the grasses were harvested at different stages of maturity, the percentage of protein as an average of all the grasses decreased with increasing age. Thus, in 1934 the percentage of protein decreased from 7.96 per cent in May to 3.83 per cent in December. Where the average figures for both years are used the protein content decreased from 5.57 per cent in July to 4.19 per cent in November.

Analyses of Grass Samples‡

Table 3. Percentage Composition—Samples clipped monthly

Date Clipped	Grasses	Chemical Composition					Mineral Content			
		Protein	Fat	Crude Fiber	N.F.E.	Water	Ash	Calcium	Phosphorus	Magnesia
2/ 2/34	Native†	3.28	.67	32.19	48.65	7.37	7.84	.41	.044	.....
3/17/34	Native†	3.55	1.01	30.21	48.05	7.71	9.47	.39	.048	.....
4/20/34	Angleton	9.17	2.45	20.75	40.57	6.91	20.15	.75	.153	.42
	Bermuda	6.61	1.43	15.50	33.18	5.68	37.60	.41	.105	.30
	Carpet	5.87	1.25	20.60	42.27	7.44	22.57	.34	.083	.30
	Dallis	7.12	1.93	20.19	38.01	6.38	26.37	.50	.092	.36
	Mixed Improved*	7.05	1.56	22.62	41.91	7.04	19.82	.44	.096	.21
	Native†	7.67	2.03	23.89	44.67	6.82	14.92	.66	.100	.....
5/16/34	Angleton	9.66	2.85	22.78	41.03	6.90	16.78	.77	.149	.....
	Bermuda	10.26	1.79	21.49	43.79	6.93	15.74	.36	.140	.....
	Carpet	10.16	1.50	22.76	42.99	8.14	14.45	.34	.122	.....
	Dallis	11.61	2.18	23.80	40.83	7.00	14.58	.46	.153	.59
	Mixed Improved*	10.15	2.93	26.06	40.49	7.03	13.34	.....	.....	.....
	Native†	9.99	1.81	26.47	43.39	7.53	10.81	.61	.144	.37
6/19/34	Angleton	6.25	3.37	22.23	50.23	6.66	11.26	.76	.087	.41
	Bermuda	8.43	1.94	21.60	48.08	6.67	13.28	.37	.109	.....
	Carpet	9.05	2.50	22.05	48.62	6.76	11.02	.46	.105	.42
	Dallis	9.63	3.43	23.88	46.68	6.78	9.60	.46	.118	.....
	Mixed Improved*	8.29	2.51	24.94	48.40	6.50	9.36	.51	.114	.48
	Native†	7.54	2.42	26.72	46.55	6.40	10.37	.54	.083	.47
7/17/34	Angleton	7.93	2.77	22.98	47.44	6.88	12.00	.59	.131	.....
	Bermuda	10.90	2.15	22.55	47.40	6.98	10.02	.41	.131	.....
	Carpet	11.09	2.42	22.00	49.40	7.53	7.56	.56	.127	.....
	Dallis	11.00	2.95	26.33	43.21	7.28	9.23	.41	.153	.....
	Mixed Improved*	9.66	2.38	25.80	45.43	7.53	9.20	.53	.127	.....
	Native†	9.3	1.86	27.66	45.84	6.62	8.66	.43	.122	.....
8/16/34	Angleton	7.65	2.44	26.15	44.17	7.83	11.76	.47	.127	.30
	Bermuda	10.35	2.01	25.14	44.84	8.37	9.29	.34	.153	.35
	Carpet	9.53	1.79	25.68	45.92	8.74	8.34	.24	.114	.37
	Dallis	9.18	2.51	29.38	42.40	7.86	8.67	.28	.135	.....
	Mixed Improved*	8.28	1.85	30.80	42.31	7.63	9.13	.31	.140	.43
	Native†	9.35	1.88	29.32	42.08	8.20	9.17	.36	.122	.43

Analyses of Grass Samples‡

Table 3. Percentage Composition—Samples clipped monthly—Continued

Date Clipped	Grasses	Chemical Composition					Mineral Content			
		Protein	Fat	Crude Fiber	N.F.E.	Water	Ash	Calcium	Phosphorus	Magnesia
9/15/34	Angleton									
	Bermuda	9.89	1.60	22.28	41.80	6.65	17.78	.33	.153	
	Carpet	9.43	1.48	24.84	43.71	8.02	12.52	.29	.135	
	Dallis	8.17	1.71	31.07	39.92	7.95	11.18	.25	.153	
	Mixed Improved*	8.33	1.72	31.06	43.14	6.62	9.13			
	Native†	9.72	1.62	28.55	38.77	9.08	12.26			
10/22/34	Angleton	7.88	2.47	26.11	42.41	7.40	13.73	.54	.135	.34
	Bermuda	10.51	2.03	23.20	47.09	6.92	10.25	.38	.153	.34
	Carpet	9.04	1.84	24.60	47.57	7.73	9.22	.29	.114	.32
	Dallis	10.57	2.66	26.16	40.53	7.19	12.89	.40	.157	.64
	Mixed Improved*	9.69	2.02	27.17	42.63	7.62	10.87	.43	.131	
	Native†									
11/20/34	Angleton	7.28	1.85	26.79	38.39	7.57	18.12	.51	.144	.31
	Bermuda	10.88	1.63	20.71	42.43	7.20	17.15	.39	.157	.47
	Carpet	9.08	1.04	19.65	44.43	7.83	17.97	.30	.131	.32
	Dallis	10.43	2.10	21.51	33.56	6.80	25.60	.47	.131	.74
	Mixed Improved*	9.73	1.69	21.48	37.42	7.92	21.76			
	Native†	9.20	1.56	24.61	42.34	7.03	15.26			
12/19/34	Angleton	6.98	1.52	26.88	46.56	7.32	10.74	.49	.135	.21
	Bermuda	8.53	1.34	20.51	43.34	7.07	19.21	.39	.114	.50
	Carpet	9.25	1.08	20.67	45.34	6.79	16.87	.32	.144	.32
	Dallis	10.35	2.09	21.22	34.91	6.49	24.94	.47	.149	.20
	Mixed Improved*	9.58	2.05	22.03	45.70	7.07	13.57			
	Native†	7.58	1.60	23.30	43.61	6.65	17.26			

‡Analysis made by the Division of Chemistry.
*Mixture of about equal parts of Bermuda, carpet and Dallis grasses.
†Largely little bluestem, *Andropogon scoparius*, with some big bluestem, *Andropogon furcatus*, and some bushy bluestem, *Andropogon glomeratus*.

Analyses of Grass Samples

Table 4. Percentage Composition—Samples clipped at various stages of growth

Date Clipped	Grasses	Chemical Composition					Mineral Content			
		Protein	Fat	Crude Fiber	N.F.E.	Water	Ash	Calcium	Phosphorus	Magnesia
5/16/34	Angleton	8.85	2.65	25.23	42.96	6.69	13.62	.76	.140	.....
	Bermuda	.....	.....	.....	.....	.....	.....	.36	.127	.....
	Carpet	7.08	1.21	23.06	46.46	6.99	15.20	.31	.114	.....
	Dallis	8.98	2.01	25.43	43.66	7.27	12.65	.40	.105	.43
	Mixed Improved*	7.78	1.93	27.49	43.19	6.56	13.05	.45	.144	.....
	Native†	7.12	2.26	27.38	46.22	7.61	9.41	.76	.122	.....
6/19/34	Angleton	4.51	2.80	26.03	50.93	6.48	9.25	.56	.066	.37
	Bermuda	6.83	1.72	21.59	51.64	6.71	11.51	.37	.092	.....
	Carpet	5.48	1.21	22.76	48.66	6.89	15.00	.36	.070	.39
	Dallis	6.75	2.22	26.27	47.63	6.82	10.31	.34	.096	.....
	Mixed Improved*	5.68	2.13	27.62	49.44	6.63	8.50	.50	.074	.38
	Native†	4.70	2.71	27.74	49.95	6.61	8.29	.90	.066	.39
7/17/34	Angleton	5.53	3.77	28.80	46.82	6.76	8.32	.42	.092	.34
	Bermuda	6.70	1.81	22.98	49.20	6.77	12.54	.32	.083	.....
	Carpet	6.35	1.40	24.03	49.41	7.39	11.42	.34	.092	.....
	Dallis	6.36	2.21	27.97	47.42	7.52	8.52	.35	.092	.....
	Mixed Improved*	5.43	1.86	28.50	49.01	7.16	8.04	.47	.074	.....
	Native†	5.37	3.24	27.49	48.91	7.19	7.80	.91	.100	.....
8/17/34	Angleton	4.89	1.83	32.79	43.60	7.77	9.12	.32	.100	.36
	Bermuda	6.89	1.71	24.83	49.79	8.05	8.73	.35	.105	.32
	Carpet	6.43	1.28	27.09	47.18	8.49	9.53	.27	.079	.33
	Dallis	6.67	1.94	32.08	42.33	8.48	8.50	.24	.122	.....
	Mixed Improved*	6.15	1.99	30.54	46.14	7.71	7.47	.42	.100	.34
	Native†	5.40	2.35	28.32	46.30	7.93	8.70	.76	.105	.....
9/15/34	Angleton	3.65	1.69	35.79	42.83	7.72	8.32	.29	.070	.....
	Bermuda	5.60	1.53	25.53	49.14	6.69	11.51	.34	.092	.....
	Carpet	5.61	1.28	29.15	45.56	7.67	10.73	.25	.079	.....
	Dallis	5.85	1.61	34.54	42.21	7.93	7.86	.27	.105	.....
	Mixed Improved*	5.54	1.66	32.63	45.57	6.71	7.89	.....	.....	.....
	Native†	4.55	1.82	31.40	45.63	8.90	7.70	.....	.....	.....

Table 4. Percentage Composition—Samples clipped at various stages of growth—Continued

Date Clipped	Grasses	Chemical Composition					Mineral Content			
		Protein	Fat	Crude Fiber	N.F.E.	Water	Ash	Calcium	Phos-phorus	Mag-nesia
10/22/34	Angleton	2.40	1.55	38.84	40.65	7.39	9.17	.26	.048	.21
	Bermuda	5.37	1.44	25.81	49.35	7.12	10.91	.35	.079	.29
	Carpet	5.88	.93	28.75	45.71	8.28	10.45	.21	.092	.30
	Dallis	5.02	1.55	32.38	45.14	7.64	8.27	.33	.070	.33
	Mixed Improved*	5.00	1.67	33.28	44.88	7.47	7.70	.31	.070	.....
	Native†	3.61	1.77	31.59	47.77	7.30	7.96	.....	.....	.....
11/20/34	Angleton	2.05	1.42	38.89	40.70	7.96	8.98	.31	.035	.....
	Bermuda	5.28	1.27	25.32	50.56	6.84	10.73	.36	.074	.08
	Carpet	5.10	.98	27.08	46.06	8.54	12.24	.30	.087	.24
	Dallis	5.18	1.51	33.12	41.76	7.79	10.64	.33	.066	.40
	Mixed Improved*	4.95	1.89	32.62	44.14	7.71	8.69	.....	.....	.....
	Native†	3.50	1.63	32.24	46.22	8.14	8.27	.....	.....	.....
12/19/34	Angleton	1.95	1.25	41.45	40.06	6.72	8.57	.30	.061	.19
	Bermuda	4.40	1.10	24.79	48.33	7.20	14.18	.34	.066	.12
	Carpet	4.45	1.14	28.76	47.08	7.37	11.20	.34	.070	.28
	Dallis	4.85	1.42	33.07	43.94	7.24	9.48	.34	.092	.33
	Mixed Improved*	4.48	1.31	31.40	44.63	8.01	10.17	.....	.....	.....
	Native†	2.85	1.45	33.70	46.53	8.28	7.19	.....	.....	.....
2/ 2/34	Salt Grass	3.90	2.39	33.42	48.93	6.54	4.82	.17	.061	.....
3/ 7/34	Salt Grass	4.08	2.41	32.63	49.34	7.21	4.33	.16	.087	.....
7/17/34	Salt Grass	4.30	2.69	30.50	49.30	7.23	5.98	.27	.070	.....
8/17/34	Salt Grass	4.93	2.67	30.08	47.40	7.52	7.40	.26	.061	.....
9/15/34	Salt Grass	5.83	2.08	30.85	45.85	8.23	7.16	.27	.083	.....
10/22/34	Salt Grass	4.95	2.25	31.82	45.21	7.39	8.38	.20	.066	.32
11/20/34	Salt Grass	3.70	2.28	34.33	45.49	7.62	6.58	.24	.052	.33
12/19/34	Salt Grass	2.88	1.77	33.61	48.45	7.88	5.41	.19	.039	.07

*Mixture of about equal parts of Bermuda, Carpet and Dallis grasses.
†Largely little bluestem, *Andropogon scoparius*, with some big bluestem, *Andropogon furcatus*, and some bushy bluestem, *Andropogon glomeratus*.

Analyses of Grass Samples‡

Table 5. Percentage Chemical Composition—Samples clipped monthly

Date Clipped	Grasses	Chemical Composition					Mineral Content			
		Protein	Fat	Crude Fiber	N.F.E.	Water	Ash	Calcium	Phosphorus	Magnesia
4/19/35	Angleton	8.40	2.33	22.04	36.51	7.03	23.69	.73	.131	.....
	Bermuda	10.83	2.12	23.51	41.52	8.30	13.72	.49	.153	.....
	Carpet	10.35	1.89	21.34	42.54	8.08	15.80	.43	.131	.....
	Dallis	14.16	2.79	21.62	38.57	8.51	14.35	.48	.197	.....
	Mixed Improved*	10.68	1.98	21.91	41.08	8.24	16.11	.58	.149	.....
	Native†	.....	.....	.....	.....	.....	.....	.....	.....	.....
7/19/35	Angleton	7.16	2.42	25.89	45.32	7.09	12.12	.65	.100	.....
	Bermuda	10.07	2.08	21.72	45.43	7.44	13.26	.41	.127	.....
	Carpet	8.41	1.57	26.68	45.63	8.83	8.88	.29	.114	.....
	Dallis	10.85	2.42	24.82	40.20	7.89	13.82	.54	.140	.....
	Mixed Improved*	8.21	2.01	26.31	47.09	7.06	9.32	.44	.118	.35
	Native†	9.81	2.17	28.75	41.06	7.38	10.83	.56	.127	.....
8/17/35	Angleton	6.59	2.39	24.66	44.57	10.04	11.75	.62	.092	.19
	Bermuda	8.78	2.29	22.45	49.54	8.78	8.16	.34	.114	.37
	Carpet	8.96	1.94	24.49	47.25	9.64	7.72	.34	.109	.27
	Dallis	9.78	2.33	26.52	43.58	8.67	9.12	.46	.114	.54
	Mixed Improved*	8.09	1.89	26.09	46.53	10.10	7.30	.41	.118	.....
	Native†	8.15	1.91	28.31	42.88	10.05	8.70	.46	.109	.....
9/18/35	Angleton	8.27	2.43	23.50	41.34	11.44	13.02	.61	.122	.....
	Bermuda	10.00	2.20	22.68	47.78	8.21	9.13	.43	.140	.....
	Carpet	10.27	1.83	23.86	47.30	8.75	7.99	.38	.127	.....
	Dallis	11.11	2.40	24.76	40.23	8.03	13.47	.46	.149	.....
	Mixed Improved*	9.58	1.99	26.35	46.53	8.11	7.44	.39	.135	.42
	Native†	11.07	2.26	26.51	41.12	8.39	10.65	.44	.157	.46
10/17/35	Angleton	9.62	2.41	23.82	35.62	11.46	17.07	.69	.140	.29
	Bermuda	10.41	1.77	20.29	37.09	11.83	18.61	.36	.162	.35
	Carpet	9.01	1.43	22.81	41.23	12.74	12.78	.30	.144	.48
	Dallis	10.82	1.89	20.27	37.83	10.93	18.26	.51	.149	.53
	Mixed Improved*	9.50	1.37	22.51	40.02	11.43	15.17	.43	.140	.....
	Native†	11.23	2.11	24.11	38.04	10.64	13.87	.48	.149	.....
11/21/35	Angleton	7.85	2.70	26.22	40.29	8.82	14.12	.48	.122	.....
	Bermuda	8.13	2.03	19.70	42.85	8.65	18.64	.34	.109	.....
	Carpet	8.34	1.64	20.12	44.19	8.15	17.56	.28	.100	.....
	Dallis	9.55	2.52	19.15	38.51	7.78	22.49	.46	.100	.....
	Mixed Improved*	8.89	2.09	19.21	43.71	8.38	17.72	.41	.118	.....
	Native†	8.97	2.23	19.57	39.62	7.32	22.29	.51	.118	.....

‡Analyses made by the Division of Chemistry.
*Mixture of about equal parts of Bermuda, Carpet and Dallis grasses.
†Largely little bluestem, *Andropogon scoparius*, with some big bluestem, *Andropogon furcatus*, and some bushy bluestem, *Andropogon glomeratus*.

Analyses of Grass Samples‡

Table 6. Percentage Composition—Samples clipped at various stages of growth

Date Clipped	Grasses	Chemical Composition					Mineral Content			
		Protein	Fat	Crude Fiber	N.F.E.	Water	Ash	Calcium	Phosphorus	Magnesia
7/19/35	Angleton	3.23	1.72	37.73	41.94	7.79	7.59	.36	.044	.....
	Bermuda	5.90	1.81	22.95	50.80	7.33	11.21	.33	.079	.....
	Carpet	6.16	1.63	24.86	46.32	8.70	12.33	.32	.083	.....
	Dallis	6.16	1.84	29.37	45.28	7.39	9.96	.35	.083	.....
	Mixed Improved*	5.30	1.83	30.23	46.77	6.87	9.00	.51	.083	.....
	Native†	4.34	1.73	30.01	47.04	6.65	10.23	.46	.070	.15
8/17/35	Angleton	2.85	1.75	36.53	40.95	10.68	7.24	.31	.039	.09
	Bermuda	4.94	1.59	22.33	50.69	9.18	11.27	.30	.066	.21
	Carpet	5.67	1.29	25.90	47.60	9.57	9.97	.28	.079	.27
	Dallis	5.33	1.83	30.88	43.46	7.92	10.58	.30	.074	.50
	Mixed Improved*	4.76	1.70	30.05	45.32	9.71	8.46	.44	.066	.....
	Native†	3.81	1.66	30.56	45.73	9.33	8.91	.41	.066	.....
9/18/35	Angleton	2.27	1.70	37.55	41.66	10.24	6.58	.28	.057	.....
	Bermuda	5.06	1.62	22.57	50.88	8.48	11.39	.42	.074	.....
	Carpet	5.50	1.48	27.80	48.39	8.01	8.82	.27	.074	.34
	Dallis	5.52	1.74	31.52	44.52	9.05	7.65	.29	.083	.....
	Mixed Improved*	4.88	1.65	30.59	47.79	7.79	7.30	.40	.079	.29
	Native†	3.74	1.66	31.08	47.24	8.04	8.24	.37	.061	.23
10/17/35	Angleton	2.08	1.70	35.62	40.57	12.72	7.31	.27	.035	.....
	Bermuda	4.76	1.43	23.15	46.34	11.19	13.13	.31	.070	.41
	Carpet	4.71	1.15	25.60	44.99	11.69	11.86	.40	.070	.27
	Dallis	4.56	1.49	29.32	44.02	11.66	8.95	.37	.066	.34
	Mixed Improved*	4.61	1.57	27.34	45.03	11.39	10.06	.45	.061	.....
	Native†	3.42	1.66	29.24	47.85	10.25	7.58	.37	.052	.....
11/21/35	Angleton	2.22	1.77	36.06	42.56	8.87	8.52	.31	.031	.....
	Bermuda	4.64	1.61	21.52	47.86	9.21	15.16	.31	.057	.....
	Carpet	4.80	1.25	26.26	45.62	9.25	12.82	.34	.052	.....
	Dallis	4.89	1.26	24.76	37.91	8.84	22.34	.46	.052	.....
	Mixed Improved*	4.45	1.84	28.76	47.15	9.19	8.61	.45	.052	.....
	Native†	3.15	1.78	29.69	46.29	8.91	10.18	.43	.044	.....
2/20/35	Salt Grass (1)	11.43	1.98	28.75	42.53	6.59	8.72	.36	.153	.....
5/20/35	Salt Grass (2)	5.51	1.75	33.29	46.87	6.58	6.00	.16	.066	.....
6/20/35	Salt Grass (3)	5.01	2.07	34.33	44.15	8.07	6.37	.18	.066	.31
10/17/35	Salt Grass (3)	4.78	1.96	30.89	41.09	14.54	6.74	.29	.057	.....

‡Analyses made by the Division of Chemistry.
*Mixture of about equal parts of Bermuda, Carpet and Dallis grasses.
†Largely little bluestem, *Andropogon scoparius*, with some big bluestem, *Andropogon furcatus*, and some bushy bluestem, *Andropogon glomeratus*.
(1) Second growth on burned-over land. (2) Three-fourths mature. (3) Mature.

Table 7. Protein content‡ of various grasses harvested at monthly intervals and at different stages of growth in 1934 and 1935

Month harvested	Kind of grass	Percentage of protein when harvested at					
		Monthly intervals			Different stages of growth		
		1934	1935	Average	1934	1935	Average
April	Angleton	9.17	8.40	8.79			
	Bermuda	6.61	10.83	8.72			
	Carpet	5.87	10.35	8.11			
	Dallis	7.12	14.16	10.64			
	Mixed improved*	7.05	10.68	8.87			
	Native†	7.67	.....	.....			
	Average	7.25	10.88	9.03			
May	Angleton	9.66	.....	.....	8.85		
	Bermuda	10.26	.....	.....	.....		
	Carpet	10.16	.....	.....	7.08		
	Dallis	11.61	.....	.....	8.98		
	Mixed improved*	10.15	.....	.....	7.78		
	Native†	9.99	.....	.....	7.12		
	Average	10.31	.....	.....	7.96		
June	Angleton	6.25	.....	.....	4.51		
	Bermuda	8.43	.....	.....	6.83		
	Carpet	9.05	.....	.....	5.48		
	Dallis	9.63	.....	.....	6.75		
	Mixed improved*	8.29	.....	.....	5.68		
	Native†	7.54	.....	.....	4.70		
	Average	8.20	.....	.....	5.66		
July	Angleton	7.93	7.16	7.55	5.53	3.23	4.38
	Bermuda	10.90	10.07	10.49	6.70	5.90	6.30
	Carpet	11.09	8.41	9.75	6.35	6.16	6.26
	Dallis	11.00	10.85	10.93	6.36	6.16	6.26
	Mixed improved*	9.66	8.21	8.94	5.43	5.30	5.37
	Native†	9.36	9.81	9.59	5.37	4.34	4.86
	Average	9.99	9.09	9.54	5.96	5.18	5.57
August	Angleton	7.65	6.59	7.12	4.89	2.85	3.87
	Bermuda	10.35	8.78	9.57	6.89	4.94	5.92
	Carpet	9.53	8.96	9.25	6.43	5.67	6.05
	Dallis	9.18	9.78	9.48	6.67	5.33	6.00
	Mixed improved*	8.28	8.09	8.19	6.15	4.76	5.46
	Native†	9.35	8.15	8.75	5.40	3.81	4.61
	Average	9.06	8.39	8.72	6.07	4.56	5.32
September	Angleton	.....	8.27	.....	3.65	2.27	2.96
	Bermuda	9.89	10.00	9.95	5.60	5.06	5.33
	Carpet	9.43	10.27	9.85	5.61	5.50	5.56
	Dallis	8.17	11.11	9.64	5.85	5.52	5.69
	Mixed improved*	8.33	9.58	8.96	5.54	4.88	5.21
	Native†	9.72	11.07	10.40	4.55	3.74	4.15
	Average	9.11	10.05	9.76	5.13	4.50	4.82
October	Angleton	7.88	9.62	8.75	2.40	2.08	2.24
	Bermuda	10.51	10.41	10.46	5.37	4.76	5.07
	Carpet	9.04	9.01	9.03	5.88	4.71	5.30
	Dallis	10.57	10.82	10.70	5.02	4.56	4.79
	Mixed improved*	9.69	9.50	9.60	5.00	4.61	4.81
	Native†	.....	11.23	.....	3.61	3.42	3.52
	Average	9.54	10.10	9.71	4.55	4.02	4.29

Table 7. Protein content‡ of various grasses harvested at monthly intervals and at different stages of growth in 1934 and 1935—Continued

Month harvested	Kind of grass	Percentage of protein when harvested at					
		Monthly intervals			Different stages of growth		
		1934	1935	Average	1934	1935	Average
November	Angleton	7.28	7.85	7.57	2.05	2.22	2.14
	Bermuda	10.88	8.13	9.51	5.28	4.64	4.96
	Carpet	9.08	8.34	8.71	5.10	4.80	4.95
	Dallis	10.43	9.55	9.99	5.18	4.89	5.04
	Mixed improved*	9.73	8.89	9.31	4.95	4.45	4.70
	Native†	9.20	8.97	9.02	3.50	3.15	3.33
	Average	9.43	8.62	9.02	4.34	4.03	4.19
December	Angleton	6.98	.....	.....	1.95		
	Bermuda	8.53	.....	.....	4.40		
	Carpet	9.25	.....	.....	4.45		
	Dallis	10.35	.....	.....	4.85		
	Mixed improved*	9.58	.....	.....	4.48		
	Native†	7.58	.....	.....	2.85		
	Average	8.71	.....	.....	3.83		

‡Analyses made by the Division of Chemistry.
*Mixture of about equal parts of Bermuda, carpet, and Dallis grasses.
†Largely little bluestem with some big bluestem and some bushy bluestem.

In general the grasses had a slightly higher protein content in 1935 than in 1934.

These data show that the young succulent growth of grass obtained by clipping at frequent intervals contains much more protein and is more nutritious than mature grass.

Percentage of Phosphorus

The percentage of phosphorus gradually decreased with increasing age of the grass, as shown in Table 8. Thus, the average percentage of

Table 8. Percentage of phosphorus‡ in grasses harvested at monthly intervals and different stages of growth in 1934 and 1935

Month harvested	Kind of grass	Percentage of phosphorus when harvested at					
		Monthly intervals			Different stages of growth		
		1934	1935	Average	1934	1935	Average
April	Angleton	.153	.131	.144	.140		
	Bermuda	.105	.153	.131	.127		
	Carpet	.083	.131	.100	.114		
	Dallis	.092	.197	.144	.105		
	Mixed improved*	.096	.149	.122	.144		
	Native†	.100	.....	.....	.122		
	Average	.105	.153	.131	.127		
May	Angleton	.149					
	Bermuda	.140					
	Carpet	.122					
	Dallis	.153					
	Mixed improved*	.....					
	Native†	.144					
	Average	.140					

Table 8. Percentage of phosphorus‡ in grasses harvested at monthly intervals and different stages of growth in 1934 and 1935—Continued

Month harvested	Kind of grass	Percentage of phosphorus when harvested at					
		Monthly intervals			Different stages of growth		
		1934	1935	Average	1934	1935	Average
June	Angleton	.087	.....	.....	.066		
	Bermuda	.109	.....	.....	.092		
	Carpet	.105	.....	.....	.070		
	Dallis	.118	.....	.....	.096		
	Mixed improved*	.114	.....	.....	.074		
	Native†	.083	.....	.....	.066		
	Average	.105	.....	.....	.079		
July	Angleton	.131	.100	.118	.092	.044	.070
	Bermuda	.131	.127	.131	.083	.079	.083
	Carpet	.127	.114	.122	.092	.083	.087
	Dallis	.153	.140	.149	.092	.083	.087
	Mixed improved*	.127	.118	.122	.074	.083	.079
	Native†	.122	.127	.127	.100	.070	.087
	Average	.131	.122	.127	.087	.074	.087
August	Angleton	.127	.092	.109	.100	.039	.070
	Bermuda	.153	.114	.135	.105	.066	.087
	Carpet	.114	.109	.114	.079	.079	.079
	Dallis	.135	.114	.127	.122	.074	.100
	Mixed improved*	.140	.118	.131	.100	.066	.083
	Native†	.122	.109	.118	.105	.066	.087
	Average	.131	.109	.122	.100	.066	.083
September	Angleton	.....	.122	.....	.070	.057	.066
	Bermuda	.153	.140	.149	.092	.074	.083
	Carpet	.135	.127	.131	.079	.074	.079
	Dallis	.153	.149	.153	.105	.083	.096
	Mixed improved*	.....	.135	.....	.....	.079	.....
	Native†	.....	.157	.....	.....	.061	.....
	Average	.149	.140	.144	.087	.070	.079
October	Angleton	.135	.140	.140	.048	.035	.044
	Bermuda	.153	.162	.157	.079	.070	.074
	Carpet	.114	.144	.131	.092	.070	.083
	Dallis	.157	.149	.153	.070	.066	.070
	Mixed improved*	.131	.140	.135	.070	.061	.066
	Native†	.....	.149	.....	.....	.052	.....
	Average	.140	.149	.144	.070	.061	.066
November	Angleton	.144	.122	.135	.035	.031	.035
	Bermuda	.157	.109	.135	.074	.057	.066
	Carpet	.131	.100	.118	.087	.052	.070
	Dallis	.131	.100	.118	.066	.052	.061
	Mixed improved*	.....	.118	.....	.....	.052	.....
	Native†	.....	.118	.....	.....	.044	.....
	Average	.140	.114	.127	.066	.048	.057
December	Angleton	.135	.....	.....	.061		
	Bermuda	.114	.....	.....	.066		
	Carpet	.144	.....	.....	.070		
	Dallis	.149	.....	.....	.092		
	Mixed improved*	.....	.....	.....	.....		
	Native†	.....	.....	.....	.....		
	Average	.135	.....	.....	.066		

‡Analyses made by the Division of Chemistry.
*Mixture of about equal parts of Bermuda, carpet, and Dallis grasses.
†Largely little bluestem with some big bluestem and some bushy bluestem.

phosphorus decreased from 0.087 per cent in the grasses harvested in July to 0.057 per cent in those harvested in November. This relationship was not observed in the grasses harvested each month, although the percentage of phosphorus varied somewhat from month to month. During the two years, however, the grasses harvested at monthly intervals contained on the average 0.131 per cent of phosphorus or 1.76 times as much as the average for the grasses harvested at various stages of growth.

The average percentage of phosphorus of all the grasses harvested at monthly intervals, as a group, was the same, 0.131 per cent, during each of the two years. The content of phosphorus, however, varied from month to month in both years.

Considering now the several grasses individually when cut monthly, Bermuda grass contained on the average 0.140 per cent of phosphorus for the two years; Dallis grass, 0.140 per cent; Angleton grass, 0.131 per cent; the mixed improved grasses, 0.127 per cent; carpet grass 0.122 per cent; and native grass, 0.122 per cent. According to these figures Bermuda, Dallis, and Angleton grasses contained about the minimum amount of phosphorus for the maintenance of livestock. The amount of phosphorus in the mixed improved grasses, carpet grass, and native grass, however, falls slightly lower than 0.131 per cent, below which additional phosphorus would be needed for range cattle.

Calcium Content

Angleton grass had the highest average content of calcium, .61 per cent, during the two years 1934 and 1935, as shown in Table 9. It contained 1.36 times as much calcium as the mixed grasses, which ranked next in calcium content. Carpet grass was the lowest in calcium. This, together with the fact that carpet grass is also low in protein, phosphorus, and fats, may account for the low palatability of the grass.

In general the content of calcium of the grasses cut each month decreased slightly as the season advanced, but had a tendency to increase with age in the grasses cut at different stages of growth. On the average the grasses cut monthly contained 1.38 times as much lime as the grasses cut at different stages of growth during the two years.

Percentage of Fat

Angleton grass contained more fat, 2.43 per cent, than the other grasses, Table 10. Dallis grass followed closely with 2.35 per cent. There may be some significance in the comparatively high fat content of Angleton and Dallis grasses; it may possibly account for their high palatability. Observation has shown repeatedly that livestock prefer these grasses to other grasses in the pastures at the Angleton Station. Carpet grass contained the smallest amount of fat, only 1.68 per cent, and this, together with the fact that it also contained the lowest amount of protein, phosphorus, and calcium, may account for its relatively low palatability and feeding value.

Table 9. Calcium content‡ of grasses harvested at monthly intervals and at different stages of growth in 1934 and 1935

Month harvested	Kind of grass	Percentage of calcium when harvested at					
		Monthly intervals			Different stages of growth		
		1934	1935	Average	1934	1935	Average
April	Angleton	.75	.73	.74			
	Bermuda	.41	.49	.45			
	Carpet	.34	.43	.39			
	Dallis	.50	.48	.49			
	Mixed improved*	.44	.58	.51			
	Native†	.66	.....	.....			
	Average	.51	.54	.51			
May	Angleton	.77	.....	.....	.23		
	Bermuda	.36	.....	.....	.21		
	Carpet	.34	.....	.....	.19		
	Dallis	.46	.....	.....	.17		
	Mixed improved	.....	.....	.....	.24		
	Native†	.61	.....	.....	.20		
	Average	.51	.....	.....	.21		
June	Angleton	.76	.....	.....	.11		
	Bermuda	.37	.....	.....	.15		
	Carpet	.46	.....	.....	.11		
	Dallis	.46	.....	.....	.16		
	Mixed improved*	.51	.....	.....	.12		
	Native†	.54	.....	.....	.11		
	Average	.52	.....	.....	.13		
July	Angleton	.59	.65	.62	.15	.36	.26
	Bermuda	.41	.41	.41	.14	.33	.24
	Carpet	.56	.29	.43	.15	.32	.24
	Dallis	.41	.54	.48	.15	.35	.25
	Mixed improved	.53	.44	.49	.12	.51	.32
	Native†	.43	.56	.49	.16	.46	.31
	Average	.49	.48	.49	.14	.39	.27
August	Angleton	.47	.62	.55	.16	.31	.24
	Bermuda	.34	.34	.34	.17	.30	.24
	Carpet	.24	.34	.29	.13	.28	.21
	Dallis	.28	.46	.37	.20	.30	.25
	Mixed improved*	.31	.41	.36	.16	.44	.31
	Native†	.36	.46	.41	.17	.41	.29
	Average	.34	.44	.39	.16	.34	.26
September	Angleton	.....	.61	.....	.29	.28	.29
	Bermuda	.33	.43	.38	.34	.42	.39
	Carpet	.29	.38	.34	.25	.27	.26
	Dallis	.25	.46	.36	.27	.29	.28
	Mixed improved	.....	.39	.....	.....	.40	.....
	Native†	.....	.44	.....	.....	.37	.....
	Average	.29	.45	.36	.29	.34	.31
October	Angleton	.54	.69	.62	.26	.27	.27
	Bermuda	.38	.36	.37	.35	.31	.33
	Carpet	.29	.30	.30	.21	.40	.31
	Dallis	.40	.51	.46	.33	.37	.35
	Mixed improved*	.43	.43	.43	.31	.45	.38
	Native†	.....	.48	.....	.....	.37	.....
	Average	.41	.46	.44	.29	.36	.33

Table 9. Calcium content‡ of grasses harvested at monthly intervals and at different stages of growth in 1934 and 1935—Continued

Month harvested	Kind of grass	Percentage of calcium when harvested at					
		Monthly intervals			Different stages of growth		
		1934	1935	Average	1934	1935	Average
November	Angleton	.51	.48	.49	.31	.31	.31
	Bermuda	.39	.34	.37	.36	.31	.34
	Carpet	.30	.28	.29	.30	.34	.32
	Dallis	.47	.46	.47	.33	.46	.39
	Mixed improved*	.....	.41	.....	.....	.45	.....
	Native†	.....	.51	.....	.....	.43	.....
	Average	.42	.41	.41	.33	.39	.34
December	Angleton	.49	.....	.....	.30		
	Bermuda	.39	.....	.....	.34		
	Carpet	.32	.....	.....	.34		
	Dallis	.47	.....	.....	.34		
	Mixed improved*	.....	.....	.....	.....		
	Native†	.....	.....	.....	.....		
	Average	.41	.....	.....	.33		

‡Analyses made by the Division of Chemistry.

*Mixture of about equal parts of Bermuda, carpet, and Dallis grasses.

†Largely little bluestem with some big bluestem and some bushy bluestem.

At each date of harvesting the grasses that were cut monthly contained more fat than those harvested at various stages of growth, as shown in Table 10. The average fat content for the two years was 2.04 per cent for the grasses harvested monthly and 1.69 per cent for those harvested at various stages of growth.

Table 10. Fat content‡ of various grasses harvested at monthly intervals and at different stages of growth in 1934 and 1935

Month harvested	Kind of grass	Percentage of fat when harvested at					
		Monthly intervals			Different stages of growth		
		1934	1935	Average	1934	1935	Average
April	Angleton	2.45	2.33	2.39			
	Bermuda	1.43	2.12	1.78			
	Carpet	1.25	1.89	1.57			
	Dallis	1.93	2.79	2.36			
	Mixed improved*	1.56	1.98	1.77			
	Native	2.03	.....	.....			
	Average	1.78	2.22	1.97			
May	Angleton	2.85	.....	.....	2.65		
	Bermuda	1.79	.....	.....	.....		
	Carpet	1.50	.....	.....	1.21		
	Dallis	2.18	.....	.....	2.01		
	Mixed improved*	2.93	.....	.....	1.93		
	Native†	1.81	.....	.....	2.26		
	Average	2.18	.....	.....	2.01		

Table 10. Fat content‡ of various grasses harvested at monthly intervals and at different stages of growth in 1934 and 1935—Continued

Month harvested	Kind of grass	Percentage of fat when harvested at					
		Monthly intervals			Different stages of growth		
		1934	1935	Average	1934	1935	Average
June	Angleton	3.37	.....	.....	2.80		
	Bermuda	1.94	.....	.....	1.72		
	Carpet	2.50	.....	.....	1.21		
	Dallis	3.43	.....	.....	2.22		
	Mixed improved*	2.51	.....	.....	2.13		
	Native†	2.42	.....	.....	2.71		
	Average	2.70	.....	.....	2.16		
July	Angleton	2.77	2.42	2.60	3.77	1.72	2.75
	Bermuda	2.15	2.08	2.12	1.81	1.81	1.81
	Carpet	2.42	1.57	2.00	1.40	1.63	1.52
	Dallis	2.95	2.42	2.69	2.21	1.84	2.03
	Mixed improved*	2.38	2.01	2.20	1.86	1.83	1.85
	Native†	1.86	2.17	2.02	3.24	1.73	2.49
	Average	2.42	2.11	2.27	2.38	1.76	2.07
August	Angleton	2.44	2.39	2.42	1.83	1.75	1.79
	Bermuda	2.01	2.29	2.15	1.71	1.59	1.65
	Carpet	1.79	1.94	1.87	1.28	1.29	1.29
	Dallis	2.51	2.33	2.42	1.94	1.83	1.89
	Mixed improved*	1.85	1.89	1.87	1.99	1.70	1.85
	Native†	1.88	1.91	1.90	2.35	1.66	2.01
	Average	2.08	2.13	2.11	1.85	1.64	1.75
September	Angleton	.....	2.43	.....	1.69	1.70	1.70
	Bermuda	1.60	2.20	1.90	1.53	1.62	1.58
	Carpet	1.48	1.83	1.66	1.28	1.48	1.38
	Dallis	1.71	2.40	2.06	1.61	1.74	1.68
	Mixed improved*	1.72	1.99	1.86	1.66	1.65	1.66
	Native†	1.62	2.26	1.94	1.82	1.66	1.74
	Average	1.63	2.19	1.88	1.60	1.64	1.62
October	Angleton	2.47	2.41	2.44	1.55	1.70	1.63
	Bermuda	2.03	1.77	1.90	1.44	1.43	1.44
	Carpet	1.84	1.43	1.64	0.93	1.15	1.04
	Dallis	2.66	1.89	2.28	1.55	1.49	1.52
	Mixed improved*	2.02	1.37	1.70	1.67	1.57	1.62
	Native	.....	2.11	.....	1.77	1.66	1.72
	Average	2.20	1.83	1.99	1.49	1.50	1.50
November	Angleton	1.85	2.70	2.28	1.42	1.77	1.60
	Bermuda	1.63	2.03	1.83	1.27	1.61	1.44
	Carpet	1.04	1.64	1.34	0.98	1.25	1.12
	Dallis	2.10	2.52	2.31	1.51	1.26	1.39
	Mixed improved*	1.69	2.09	1.89	1.89	1.84	1.87
	Native†	1.56	2.23	1.90	1.63	1.78	1.71
	Average	1.65	2.20	1.93	1.45	1.59	1.52
December	Angleton	1.52	.....	.....	1.25		
	Bermuda	1.34	.....	.....	1.10		
	Carpet	1.08	.....	.....	1.14		
	Dallis	2.09	.....	.....	1.42		
	Mixed improved*	2.05	.....	.....	1.31		
	Native†	1.60	.....	.....	1.45		
	Average	1.61	.....	.....	1.28		

‡Analyses made by the Division of Chemistry.

*Mixture of about equal parts of Bermuda, carpet, and Dallis grasses.

†Largely little bluestem with some big bluestem and some bushy bluestem.

Composition of Salt Grass

Although salt grass was not included in the test of cultivated grasses for chemical analysis, samples of the grass were obtained on salt spots and on salt flats for analysis. The results of the analyses are given in Tables 4 and 6. Salt grass contained about one-half as much protein, phosphorus, and calcium as the cultivated grasses harvested at intervals during the growing season. Its fat content, however, compares favorably with that of the other grasses.

In 1935 samples of salt grass were secured at different stages of growth: second growth on burned-over land, three-fourths mature, and at maturity. The younger grass contained considerably more protein, phosphorus, and calcium than half-mature and mature grass (Table 6). These results are in general agreement with the analysis of other grass discussed previously.

The results indicate that salt grass has a low feeding value. The grass, however, has some value and is available during the winter months when other grasses are not growing. As a consequence salt grass is of importance in beef cattle production in the Gulf Coast Prairie.

FERTILIZING PERMANENT PASTURES

In the spring of 1936 a pasture fertilizer test was started on a permanent pasture sod. This land had never been plowed, but the area had been mowed twice a year for the previous six years. The sod consisted largely of carpet grass with a small amount of smut grass and common lespedeza. No weeds were present. Six treatments inclusive of the unfertilized plat, were used, each replicated four times. The plats were 10 feet by 18 feet, and the area harvested was 6 feet by 16 feet. The grass was cut with a lawn mower and the clippings were caught in a grass catcher. The time of mowing was dependent on the growth of the grass regardless of the time required, but the plats were cut when the grass reached about the maximum height the lawn mower could handle. The test was on Lake Charles clay loam soil.

The fertilizers were broadcast on the surface of the sod in the early spring. The nitrogen was supplied in ammonium sulphate and the phosphoric acid in Tennessee Valley superphosphate, which contained 34.39 per cent of available phosphoric acid. The fertilizers were applied on April 23 in 1936, two days after 1.38 inches of rain fell. The soil was moist at the time of application. Five days after the application 1.16 inches of rain fell and then from May 10 until the last of May a total of 9.43 inches of rain fell, keeping the plats flooded for several days at a time. These heavy rains might have removed part of the fertilizers applied. The same fertilizers were applied on the same plats again on March 2, 1937. The soil was fairly dry at the time the fertilizers were applied. From March 3 to March 7 a total of 2.87 inches of rain fell, the heaviest precipitation occurring on March 5, when 2.22 inches fell. A slight run-off occurred during this period and part of the fertilizers again

might have been lost, although the dry condition of the soil, together with .13 inches of rain on March 3 and 4 should have allowed part of the fertilizer to penetrate into the soil with the moisture.

The fertilizer treatments used consisted of phosphoric acid alone, and combinations of nitrogen and phosphoric acid, as shown in Table 11. As stated previously, the nitrogen was supplied in sulphate of ammonia at the rates of 100 and 200 pounds per acre, which furnish 20 pounds and 40 pounds of nitrogen, respectively. The phosphoric acid was furnished in the Tennessee Valley triple superphosphate at the rates of 116 and 232 pounds per acre, which supplied 40 pounds and 80 pounds of available phosphoric acid. Potash was not included in the experiment.

Table 11. Yield in pounds of air-dry forage per acre in fertilizer experiments on permanent pasture in 1936 and 1937

Fertilizer treatment	Pounds of air-dry forage per acre			
	1936	1937	Average	Increase over unfertilized soil
None (check)	2596	2615	2606	
116 lbs. superphosphate	2610	2676	2643	37
232 lbs. superphosphate	2608	2681	2645	39
100 lbs. sulphate of ammonia 116 lbs. superphosphate	2787	2845	2816	210
200 lbs. sulphate of ammonia 232 lbs. superphosphate	2848	2998	2923	317
200 lbs. sulphate of ammonia 116 lbs. superphosphate	2818	3076	2947	341

The yields of air-dry forage obtained from each fertilizer treatment in 1936 and 1937 are given in Table 11. The results were about the same for both years of the test. The phosphoric acid had little effect on the yield either year. The nitrogen when included with the phosphoric acid gave some increases in yield both years, although the increases probably were not profitable. The increases in yield from nitrogen were made largely during the spring months. The results with superphosphate are rather surprising and disappointing, since the soil is known to be markedly deficient in phosphoric acid. Different results may have been obtained if the fertilizer had been mixed with the soil at the time of application. Although the use of fertilizer was not profitable during the two years of the experiment, it is probable that application of superphosphate would be favorable for the growth of legumes, which in turn would increase the feeding value of the herbage. Further trials with fertilizer, however, are necessary to give conclusive results.

SUMMARY AND CONCLUSIONS

The Gulf Coast Prairie of Texas is predominantly a beef cattle region and contains one of the densest populations of range cattle in the United

States. An increase in cattle population has resulted in a decrease of the native bluestem grasses of the region and an increase in low-growing introduced pasture grasses, as carpet and Bermuda grasses. At the same time continuous heavy grazing has resulted in a tremendous increase in the growth of worthless weeds.

Dallis, carpet, Bermuda, and Angleton grasses, all of which are introduced grasses, are recommended for permanent pasture in the region.

California bur clover (toothed bur clover), White Dutch clover, and common lespedeza are the better pasture legumes for the area.

Drainage, mowing to destroy weeds and increase the feeding value of the pasturage, and seeding better grasses and clovers where these are not present are the three essentials of pasture improvement. Mowing produced a good sod in four years, and seeding on a prepared seed bed produced a good turf in two years. Mowing produced a good sward composed almost entirely of carpet grass and common lespedeza, where no seeding was done.

Seven steers on an improved pasture of Dallis, carpet, Bermuda, and Angleton grasses made average daily gains of 0.40 pounds and a gross return of $4.32 per acre per year as compared with 0.31 pounds and $3.68 for seven steers on a native pasture not mowed, although the steers on the improved pasture were sold on a lower market. The better results from the improved pasture can be attributed to the lack of weed competition and to the higher protein, fat, calcium, and phosphorus content where the grasses were kept young and tender by mowing in the early summer and fall. The steers on the native pasture made better gains in the early spring than those on the mowed pasture; but during the summer and fall they failed to make further gains, while the steers on the improved pasture continued to make gains until frost.

The native bluestem grasses made higher forage yields when in pure stands than Dallis, carpet, Bermuda, and Angleton grasses or a mixture of the first three grasses named.

In order to obtain the full value of the spring grazing of bluestem grasses, a method of pasture management is suggested whereby the bluestem grasses are grazed in the spring, allowed to grow during the summer and fall, and cut for hay in the late fall.

Grasses harvested at monthly intervals contained more protein, phosphorus, calcium, and fat than grasses harvested at different stages of maturity. As a rule, the percentage of protein, phosphorus, and fat declined as the age of grasses increased. Bermuda grass, Dallis grass, and Angleton grass when harvested monthly contained enough phosphorus for adequate animal nutrition. The other grasses, however, were deficient in phosphorus according to present feeding standards.

The use of fertilizers on permanent pastures was not profitable. Although sulphate of ammonia, which is a nitrogenous fertilizer, produced some increases in yield, the increases were not large enough to return a profit. Superphosphate did not increase the yield of grasses appreciably, although

previous work with fertilizers on field crops has shown that the soil is deficient in phosphorus.

It is apparent that land owners are becoming more appreciative of the value and interest of game and because of this it is necessary to state that the transformation of areas of native pasture into highly improved permanent pasture by mowing or seeding will drive out the game at least temporarily. It is not anticipated, however, that a sufficient acreage will be seeded or mowed at any one time to seriously affect the population of game. Undoubtedly there are some areas which can be drained only with great difficulty and expense and may therefore bring a more satisfactory return as game preserves.