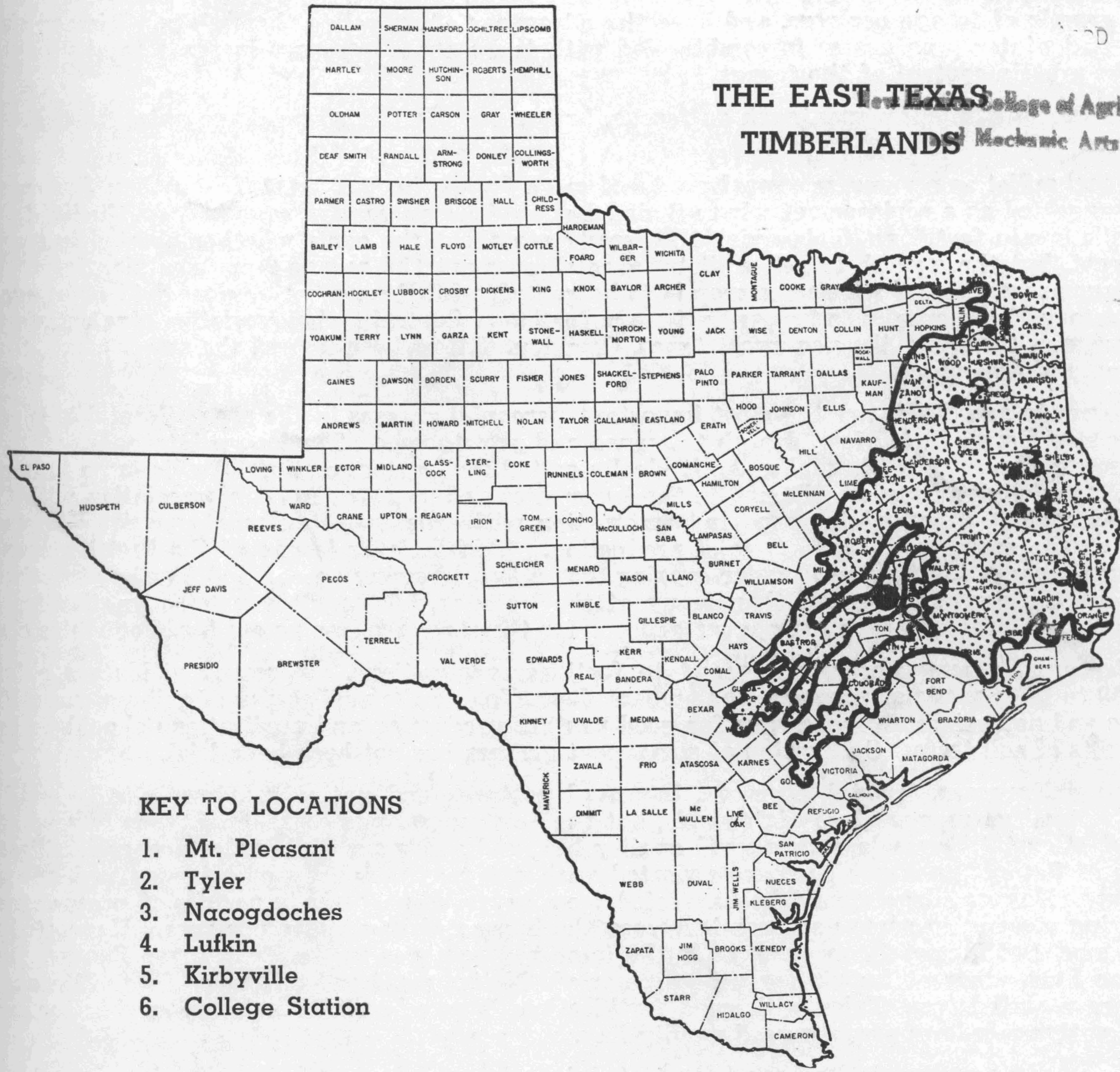
Pasture, Hay and Silage Crops for East Texas



KEY TO LOCATIONS

1. Mt. Pleasant
2. Tyler
3. Nacogdoches
4. Lufkin
5. Kirbyville
6. College Station

A PART OF THE TEXAS A&M COLLEGE SYSTEM

TEXAS AGRICULTURAL EXPERIMENT STATION

R. D. LEWIS, DIRECTOR, COLLEGE STATION, TEXAS

DIGEST

The East Texas Timberlands area has a warm, temperate and humid climate with an average annual rainfall of 35 to 50 inches and 234 to 266 days of growing weather. From the standpoint of productivity and the need for conservation practices, the area is well suited to pasture and livestock production. The rapid increase in cattle population and the decrease in cultivated crops in the area during the past 2 decades indicate a trend toward better pastures and greater livestock production.

A wide range of annual and perennial crops are adapted to the area. Winter pasture crops primarily are annuals, with the small grains, particularly oats and rye, being the best producers. Mustang and Alamo oats and Abruzzi rye are among the best small grain varieties. Goliad barley is a good, early producer in the southern part of the area. A rotation grazing system whereby parts of the pasture are rested 3 to 4 weeks between grazings increases total production and lengthens the period of producton.

Annual grasses, such as rescue and ryegrass, make good winter pasture, producing 2,000 to 5,000 pounds of forage per acre, and have the advantage of reseeding themselves. Crimson clover, vetch and winter peas grown in combination with these annual grasses increase total production and the protein content of the forage.

Perennial winter grasses, such as fescue, brome and Hardinggrass, have not been successful in the area.

Pearl millet as a summer annual produced more forage in Southeast Texas than Sudangrass. It is suggested as a replacement where Sudan has not been successful, especially on the light, shallow soils low in fertility. Sudan yields generally are about the same whether planted in rows or broadcast, but the growth is better distributed throughout the season from row plantings. Row plantings are suggested where the crop is to be grazed, while broadcast or close-drill plantings are satisfactory if the crop is to be used primarly for hay. Several Sudan varieties give satisfactory performance, including the non-sweet types, Common, Tift and Piper, and the sweet types, Sweet, Lahoma and Greenleaf.

Bermuda and Dallis are the most important perennial grasses in the area. Coastal is superior to Common Bermuda in yield, drouth tolerance and growth type. The longer internode length and more upright growth of Coastal make it ideally suited for hay production. Dallis is an important grass, especially on heavier soils and in the lower sites and usually grows in association with Common Bermuda. Annual legumes in combination with permanent grasses, especially Bermuda, lengthen the season and increase total production. White clover is one of the best legumes for pastures because it will reseed under grazing, has a long growing season and has less smothering effect on the permanent grass than many of the legumes. Narrowleaf vetch, a native legume, shows promise for use with permanent grasses for the same reasons as outlined for white clover.

Perennial summer grasses respond to fertilizer applications. Increased yields are obtained with 90 to 120 pounds of nitrogen, the amount depending on the availability of soil moisture. Phosphorus and potassium are necessary for good pasture production and applications should be based on results of soil tests. Cultivation of permanent grasses has not been beneficial.

Annual grasses, Coastal Bermuda, improved pastures and native meadows can be used for hay. Annual grasses produce high yields, but the hay generally is coarse and tends toward stemminess. Coastal Bermuda makes good quality hay, and yields are high under proper fertilization. Yields of 7 to 12 tons per acre are reported with 400 to 800 pounds of nitrogen and adequate moisture. Hay or silage should be harvested from improved pastures in periods of excess growth. Deferring grazing in some pastures increases the harvested hay yields per acre. Harvested hay yields averaged almost 1 ton per acre in the improved pastures at the East Texas Pasture Investigation Laboratory at Lufkin for a 3-year period. Native meadow hay yields of 2 to 2½ tons per acre are reported from Tyler with good fertilization. Where fertilized and harvested in the proper stage, native meadows produce good quality hay.

Many crops and varieties have been tested for silage production. Corn produces good yields of high quality silage in most years. The higher-yielding sorghum varieties generally produce more than corn. The choice of a sorghum variety should be determined by the length of growing season or planting date and harvesting equipment. Varieties such as Red Top, Sumac and Hegari will mature in 70 to 75 days, Atlas in 80 to 90 days, Honey and Tracy in 100 to 120 days and Sart and Hodo in 130 to 150 days. Honey, Tracy, Sart and Hodo may reach a height of 10 to 12 feet and require auxiliary powered equipment for harvesting. Yields vary widely, depending on climatic conditions, soil fertility and variety. Row seedings for silage produce as much as broadcast seedings and are easier to harvest.

Pasture, Hay and Silage Crops for East Texas

E. C. Holt, P. R. Johnson, Mark Buckingham, H. C. Hutson, J. K. Crouch and J. R. Wood*

THE EAST TEXAS TIMBERLANDS comprise an area bordered by the Red River on the north, Louisiana on the east, the Coast Prairie on the south and the Blackland and Grand Prairies on the west. Pastures and the need for pasture research have increased in importance in this area in recent years. As land has been taken out of cultivation, much of it has been put into pastures. Much of that not actually improved for pastures has been subject to grazing. This is reflected in an increase in cattle population of more than 70 percent since 1940.

The climate is warm, temperate and humid, with an average rainfall of from 35 inches in the southwestern portion to more than 50 inches in the southeastern portion. Average length of the growing season ranges from 234 days in the northern portion to 266 days in the southern portion. Summer temperatures often exceed 100° F with a maximum of 115° and a July average of 84°. The long, warm, humid season is ideal for rapid decomposition of organic matter. This condition, plus the types of soils common in the area, have led to eroded soils low in organic matter. Thus, both from a conservation and a productivity standpoint, the area is well suited to pasture and livestock production.

The soils are mostly fine sands and fine sandy loams, light colored and low in organic matter content and inherent fertility. The soils generally are deficient in nitrogen, phosphorus and potassium and are slightly to strongly acid in reaction. Lime is required in many instances for the best growth of the better legumes and grasses. The redland soils in the central section are not as deficient in potassium and calcium as the more acid soils. Likewise, some of the soils along the western edge of the area are less deficient in potassium and calcium. Crops growing on most of these soils show good response to fertilizers.

The monthly rainfall distribution pattern for most of the area shows a decrease in July, August and September. While average rainfall for most of the area may exceed 2.5 inches monthly, the distribution may be irregular, resulting in drouth periods of 1 to 3 months or longer. Thus, there is need for a forage and feed reserve program along with a grazing program. This report covers production both for grazing and for hay and silage.

*Respectively, professor, Department of Agronomy, College Station, Texas; superintendent, Substation No. 2, Tyler, Texas; formerly, in charge Dairy Investigations Laboratory, Mt. Pleasant, Texas; superintendent, Substation No. 11, Nacogdoches, Texas; in charge East Texas Pasture Investigations Laboratory, Lufkin, Texas; and superintendent, Substation No. 22, Kirbyville, Texas.

This report is concerned mainly with research conducted at six locations in East Texas. These *locations, shown on the cover map, are* College Station, Kirbyville, Lufkin, Nacogdoches, Tyler and Mt. Pleasant. The research locations at

CONTENTS

TABLE 1. FORAGE YIELD OF CAMELLIA OATS AS INFLUENCED BY RATE OF SEEDING AT KIRBYVILLE, 1953-54

Seeding rate, bushels per acre	Pounds of air-dry forage per acre			
	Early winter	Mid-winter	Late winter and early spring	Total
1.0	610	1610	2730	4950
1.5	1020	1440	2520	4980
2.0	1090	1610	2440	5140
2.5	910	1630	2650	5190
3.0	1090	1750	2520	5360
3.5	1340	1760	2330	5430
4.0	1160	1710	2470	5340

Kirbyville, Lufkin and Mt. Pleasant are concerned primarily with forage and pasture research. The other locations, including some not listed, have interests in other agricultural problems of the area. Most of the work reported was done between 1948 and 1956.

WINTER PASTURE CROPS

Small Grains

Small grains are the most important crops for late fall, winter and early spring grazing in East Texas. Generally they are seeded in October. When moisture is available for early germination, they furnish some grazing by late November or early December.

Small grains seeded on unprepared seedbeds produce less than seedings on prepared seedbeds. No actual research has been done on the degree of seedbed preparation necessary. A firm seedbed is preferable with the seed placed 1 to 2 inches deep in the soil. If soil moisture is likely to be limited following seeding, rolling or cultipacking is desirable.

Rate of Seeding

Rate of seeding small grains may vary over a wide range. Table 1 indicates that seeding rates of 1 to 4 bushels per acre had no significant influence on total yield of Camellia oats. There was a significant difference in early forage production in favor of the higher seeding rates. The higher seeding rates have some value since the need for forage is greater in late fall and early winter than in the spring. These results suggest the use of 1½ to 2½ bushels of oats per acre and not more than 3 bushels. Similar results have been obtained in other areas of Texas.

Figure 1. Type and amount of growth of small grain varieties at College Station, January 1957.

Fertilization

Fertilizer requirements of small grains for grazing depend on the soil type and fertility level. Fertilizer tests were conducted in 1950-51 at Kirbyville on Bowie fine sandy loam and at Cleveland on Hockley fine sandy loam. Maximum forage yields were obtained at Kirbyville with 90 pounds of nitrogen and 30 pounds of phosphoric acid. At Cleveland, maximum production was obtained with 60 pounds of nitrogen and 60 pounds of phosphoric acid.

Phosphorus and potassium requirements vary with soil type. The amount applied should be based on the results of soil tests. The amount of nitrogen to be used depends on availability of soil moisture and the grazing practice. Where a rotation grazing practice is being followed, a 30-pound nitrogen application following each grazing is suggested. Sixty to 90 pounds of nitrogen can be used effectively in this way.

Varieties

Varieties differ not only in total production, but also in distribution of production during the growing season. Oats have been classified as spring, winter and intermediate types. All oats are fall-seeded in this area except in the northern part where spring oats, if used, are spring-seeded. The spring-types are upright in growth habit, usually earlier in forage production and more susceptible to cold damage. Winter-type oats have a decumbent growth habit in the fall and winter

TABLE 2. FORAGE YIELD OF SMALL GRAIN VARIETIES AT MT. PLEASANT, NACOGDOCHES AND KIRBYVILLE, 1952-57[1]

Variety	Mt. Pleasant	Nacogdoches	Kirbyville
Mustang oats	3740	4210	4330
Alamo oats	3670	3450	4040
Atlas 66 wheat	3210	3070	3950
Abruzzi rye	3790	3110	3390
Goliad barley	2310	2740	2940
New Nortex oats	3700	3910	
Bronco oats	3570	4450	
Cordova barley	3160	3700	
Quanah wheat	2470	3700	
Travis wheat		2990	3120
Bowie wheat		2420	3100
Camellia oats			4470
Victorgrain oats			4300
Ranger oats			3920
Southland oats			3500

[1]Comparable yields in pounds of air-dry forage per acre are based on results for 2 or more years.

TABLE 3. SEASONAL PRODUCTION OF FORAGE OF SEVERAL SMALL GRAIN VARIETIES AT MT. PLEASANT, 1954-55

Variety	Pounds of air-dry forage per acre			
	Late fall-early winter	Mid-winter	Late winter	Total
Abruzzi rye	1390	2740	1050	5180
Bronco oats	1130	2470	1300	4900
Mustang oats	1370	2600	900	4870
Atlas wheat	1950	2130	520	4600
Alamo oats	1920	1900	640	4460
Cordova barley	1660	2190	540	4390
Goliad barley	1690	1520	600	3810

and are late in forage production, but are cold hardy. The intermediate types are intermediate between spring and winter types in these characteristics. Figure 1 shows the type and amount of growth of a number of small grain varieties.

Results of performance tests at three locations in East Texas, Table 2, show that several varieties make good total yields. For the central and northern part of the area, the following varieties appear to be satisfactory in total production: Mustang, New Nortex and Bronco oats and Abruzzi rye. For the central and southern part, Mustang, New Nortex, Alamo, Camellia and Victorgrain oats, Goliad barley and Atlas 66 wheat. Mustang, New Nortex and Bronco are winter-types; Victorgrain is an intermediate type; and Alamo and Camellia are spring-type varieties. Mustang is resistant to leaf rust, which is one of the more serious forage disease problems on oats. Mustang also shows moderate tolerance to Helminthosporium blight. Alamo is resistant to leaf rust and stem rust, but is susceptible to Helminthosporium blight. Recommended practices of seed treatment and crop rotation should be followed in reducing the damage by this disease.

Table 3 shows differences among varieties in seasonal production. Alamo, a spring oat, Atlas wheat and the two barley varieties give good early production, but are lower in winter and spring production. Mustang and Bronco are lower in early production but higher in total production. An oat variety combining both early and sustained production would make a valuable contribution to winter forage production in East Texas. Experimental varieties are being developed and tested continually for this purpose.

Management

Management is important if high production is to be obtained. A greenhouse study at the Winter Garden station showed that oat yields are reduced 83 percent by clipping every time the plants reach a height of 3 to 4 inches. The practice of starting grazing as soon as the plants emerge also retards production even if better management practices are followed later. In the study referred to above, yields were retarded 20 percent by a single early clipping when plants were 3 to 4 inches high followed by subsequent clipping when the plants were 10 to 12 inches high.

Table 4 shows that frequent close clipping reduces the yield to about half that obtained when the plants are allowed to reach a height of 10 to 12 inches before clipping. These data show the need for a rotation grazing system in which the plants are allowed to rest at least 3 to 4 weeks between grazings. Other work shows that relatively little regrowth occurs during the first 2 weeks after removal of the top growth.

However, there are important considerations in determining the time to start grazing other than the agronomic advantage of deferring it until the plants reach a height of 10 to 12 inches. Grazing during the 6-week period from the time the plants reached a height of 4 to 6 inches until they are 10 to 12 inches high might be more important than the increased production resulting from delayed utilization. Therefore, a management system might be devised in which parts of the planting are grazed earlier and some of the production sacrificed, with grazing of the remainder of the planting being deferred until more growth and root development are attained. This

TABLE 4. FORAGE YIELD OF TWO OAT VARIETIES SEEDED ALONE AND TOGETHER AND CLIPPED AT TWO FREQUENCIES, COLLEGE STATION, 1954-55

Variety and seeding method	Pounds of air-dry forage per acre							
	Early winter[1]		Mid-winter[1]		Early spring[1]		Total	
	4 to 6[2]	10 to 12[2]	4 to 6	10 to 12	4 to 6	10 to 12	4 to 6	10 to 12
Alamo	540	1200	350	850	430	910	1320	2960
Mustang	430	770	550	1160	800	1450	1780	3380
Alamo 50%, Mustang 50%	410	1170	520	1040	610	1220	1540	3430
Alamo 50%, Mustang 50%, cross-seeded	590	900	480	810	460	1190	1530	2900

[1]Represents clippings as follows:
Early winter: 4 to 6 inches—Nov. 18, Dec. 1, Dec. 17, Jan. 3: 10 to 12 inches—Jan. 3
Mid-winter: 4 to 6 inches—Jan. 20, Feb. 9, Feb. 24: 10 to 12 inches—Feb. 24
Early spring: 4 to 6 inches—March 7, April 15: 10 to 12 inches—Apr. 15
[2]Clipped when forage reached height of 4 to 6 and 10 to 12 inches, respectively.

would be done in a grazing system in which there was a rest period of at least 4 weeks.

Frequent early clipping reduced the early production of Alamo. Under a system of frequent early use, Alamo would have no advantage in early production over Mustang.

Table 4 indicates that mechanical seed mixtures of winter and spring-type oats may have an advantage under certain management systems. Cross-seeding seem to have no advantage over single variety seedings. When Mustang and Alamo seed were mixed mechanically in a 1 to 1 ratio and the resulting stands deferred until the plants were 10 to 12 inches high, early winter production was equal to Alamo and early spring production was similar to Mustang. Total production was not increased. When the mixture was clipped earlier and more frequently, the stands behaved like Mustang and resulted in no advantage in early production. In other studies where the first clipping was delayed, some advantage in early production resulted. It is apparent that no marked advantage results from seed mixtures, but no serious disadvantages have been encountered. These studies have involved varieties of the same species. No information is available on mixtures of species that might differ in palatability and, therefore, result in differential grazing.

Other Annual Winter Grasses

Annual grasses tested in East Texas include strains of ryegrass and rescue and *Phalaris minor*. Results of some of these tests are presented in Table 5. Yields of 3,000 to 5,000 pounds of forage per acre are common. In most cases, the improved varieties produced higher yields than common sources.

Annual winter grasses generally produce less forage than the better yielding small grain varieties. Generally, they also are later in production than the spring and intermediate-type small grains. Forage quality of the annual winter grasses is similar to that of small grains. Annual grasses are better suited than small grains for growing in association with annual legumes, as will be shown in a section on grass-legume associations. Another advantage of these grasses is their ability to reseed themselves if they are allowed to mature a seed crop each spring.

TABLE 5. FORAGE YIELD OF ANNUAL WINTER GRASSES AT COLLEGE STATION AND KIRBYVILLE, 1955-57

Variety	Pounds of air-dry forage per acre			
	College Station		Kirbyville	
	1954-55	1955-56	1955-56	1956-57
Ryegrass				
Common	2290	3400	3670	5580
Gulf		3840	5000	6700
Mississippi Rust Resistant		4150	4480	
Florida Rust Resistant	2940	3260	4520	6810
Rescue				
Common	3600	3110		
Texas Rescue 46	3870	3370	3940	5260
Chapel Hill	4240	3540	3880	6620
Prairie brome	3470	3560	3780	5990
Lamont		3070		6680
Phalaris minor	1950	3300	2890	

Ryegrass

Common ryegrass seed usually are a mixture of Italian and perennial ryegrass. Perennial ryegrass acts as an annual in East Texas. Ryegrass is adapted on sandy loam to clay soils and has a rather high fertility requirement; it will not do well on sandy soil low in organic matter and plant nutrients. Ryegrass is subject to attacks of leaf rust in the spring. The disease reduces forage yields and quality and, in severe cases, may kill the plants before a seed crop is matured. If reseeding is desired, it is necessary to reduce or stop grazing for a few days during the period of seed production.

The ryegrass strains listed in Table 5 are experimental strains which possess some rust resistance. They show promise for increasing early forage production of ryegrass and assuring the production of a seed crop. Gulf Ryegrass was released by the Rice-Pasture Experiment Station at Beaumont in 1957 and seed should be available in 1958.

Rescuegrass

Rescue is a weak perennial which acts as a cool-season, reseeding annual under most Texas climatic conditions. Rescue is adapted to the more fertile soils and will not do well on poor sandy soils low in organic matter and plant nutrients. Common rescue is subject to severe attacks of mildew which reduce forage yields and quality. Most of the strains listed in Table 5 possess some degree of mildew resistance. They also are more upright in growth habit, have better seedling vigor and produce seed later in the spring than Common.

Phalaris minor

Phalaris minor is an annual canarygrass that has shown promise for early forage production in other states. It is subject to frost damage in most of Texas, except possibly the Gulf Coast, and this may be the reason it has not been particularly promising in Texas. It apparently has no advantage over ryegrass and rescue under our conditions.

Perennial Winter Grasses

Work was conducted during 1948-53 with a number of perennial cool-season grasses. Emphasis was placed on tall fescue, but a large number of other species also were tested. A summary of the results of these tests is given in Table 6. A wide range in yields was obtained from year to year. Good yields were obtained some years from the perennial grasses, but in general the performance of annuals was as good or better.

Yields of orchardgrass and Hardinggrass in these tests were about as good as tall fecue, but generally survival was not as good. Smooth bromegrass yields were low in all tests.

Other species tested at one or more locations included tall oatgrass, Reed canarygrass, tall wheatgrass, intermediate wheatgrass, perennial ryegrass, Texas wintergrass and other strains of tall fescue and bromegrass. The performance of these species and strains generally was less desirable than those shown in Table 6.

Tall fescue is a hardy, bunch-type, deep-rooted, persistent grass in other areas of the United States. Its forage quality is less desirable than that of most other perennial grasses, but, if it would persist, tall fescue would fill a need for a perennial cool-season grass. Other tests were conducted to determine the influence of rate and method of seeding on establishment, production and survival. Seeding in rows tends to increase survival, but even then performance is not satisfactory. Row seedings reduced total production at Mt. Pleasant in 1955.

Because of poor summer survival, poor fall recovery and growth of surviving plants, limitation on use of stands during the summer and low production on an annual basis, perennial cool-season grasses are of limited value and importance in East Texas. Work is being conducted with smooth brome, tall fescue and Harding toward improvement in one or more of these characteristics. Better producing and surviving types eventually may be obtained.

Winter Legumes

Winter legumes generally are not grown in pure stands for pasture because of their short season of production and the bloat hazard. However, legumes are important because of their ability to fix nitrogen from the air and the high feeding value of their forage. It was necessary to determine the potential yielding ability of a large number of legume varieties and strains in pure stands. Selected varieties were tested in combination with grasses, assuming that other varieties of the same species would react similarly. The mixture studies are reported in the following section. Results of a number of the pure stand tests are presented in Tables 7, 8 and 9.

Red Clover

Red clover is a non-reseeding, cool-season legume. In the Central and Northern States, it is a biennial, but in Texas it performs as an annual species. It has about the same climatic adaptation as crimson clover. It comes into production in East Texas about 2 weeks later than crimson and usually remains productive 2 to 4 weeks longer. This may make it useful as a hay crop. Red clover is best adapted to the heavier soils. It will not produce well on strongly acid, poorly drained or very light sandy soils.

Results of tests with red clover in Southeast Texas are presented in Table 7. Louisiana S-1, also known as Louisiana Station-1, Kenland and Louisiana Red generally produced the highest yields of forage. Louisiana Red, the earliest variety tested, usually comes into production about 1 week earlier than Louisana S-1 and 2 weeks earlier than Kenland. Port Gibson looked good in 1955 and 1956 at Orange, but further tests are needed to determine its value. With ample moisture, the production of red clover is fairly well

TABLE 6. FORAGE YIELD OF COOL-SEASON GRASSES IN EAST TEXAS

Variety	Pounds of air-dry forage per acre												
	Mt. Pleasant			Nacogdoches		Lufkin		Kirbyville				Cleveland	
	1951	1952	1953	1952	1953	1949	1950	1950	1951	1952	1953	1951	1952
Tall Tescue													
Kentucky 31	640	280	480	3840	1340	1500	2380	590	2120	2320	2410	1130	3890
Alta	740	510	760	4220		1890	1520	790	2630	3410	2410	1080	3060
Alta 144	720	660	830	4280		1640	1390	1090	2550	2120	3060	1130	2780
Smooth brome													
Achenbach						500		330	280			80	
Lincoln						460		100	910				
Southland				4240	1030				430			140	
Orchard				5560	1070	1140		940	2510			1330	
Harding				4340	2000	1190		840	1800			160	
Annual grasses													
Texas Rescue 46	2540			10060		2120		1420	2550	3270		1670	
Italian ryegrass	2240							2430	2660	2620		3080	
Mustang oats			1290		3300					2960	4540		

distributed from early April to the middle of June. Red clover is not drouth resistant and production is reduced severely in dry years.

It is not recommended that red clover replace crimson clover in the forage program where crimson is well adapted. Red clover generally must be re-established each year. The longer growing season, adaptation to heavier soils and high forage production of red clover make it worthy of consideration as an additional cool-season legume for areas of Central and East Texas.

Crimson Clover

Considerable interest in reseeding crimson clovers has been shown during the past few years in Texas and the Southeastern States. Seed of several strains and varieties are on the market. Interest has increased because of a high percentage of "hard seed" among certain selections of this clover. The coats of these "hard seeds" are impervious to water for a period of time and the seed will go through the summer without germination. As fall rains begin and temperatures become lower, these seed coats soften, water enters, the seed germinate and a volunteer crop is established. This phenomenon eliminates the necessity of planting each year. Volunteer stands have been maintained on some fields for more than 20 years. Common crimson clover does not possess sufficient hard seed to delay germination until favorable conditions occur in the fall for establishment. Farmers interested in reseeding crimson clover should, therefore, purchase seed only from those fields that have maintained successful volunteer stands for 3 years or longer.

When crimson clover seed are harvested with a combine, the seed coats may be so scratched or "scarified" that many of them are no longer impervious to water. Hand-picked samples of seed may contain 85 to 90 percent hard seed, whereas seed from the same field harvested by machinery may contain only 10 to 15 percent.

Annual forage yields for a number of crimson clover varieties are given in Table 8. No consistent differences existed among the varieties in their yield performance. Apparently the reseeding varieties are about equally well adapted. Common fails to reseed itself and was never among the highest yielding varieties. Thus, yield and reseeding ability emphasize the importance of using one of the named varieties. Autauga is

TABLE 7. YIELDS IN POUNDS OF AIR-DRY FORAGE PER ACRE OF RED CLOVER VARIETIES IN SOUTHEAST TEXAS

Date of harvest	Variety						
	Louisiana S-1	Kenland	Louisiana Red	Midland	Tennessee Purple seeded	Port Gibson	Penscott
			KIRBYVILLE				
4-25-51	520	600	1480	420	340		
5-14-51	1400	1300	1290	1290	1140		
6-6-51	870	930	970	870	820		
Total	2790	2830	3740	2580	2300		
3-17-52	120	340	440	140	360		
4-3-52	470	590	880	610	410		
5-5-52	2940	2770	3100	2610	2730		
5-30-52	570	900	340	880	740		
Total	4100	4600	4760	4240	4240		
3-14-56		600	800	570		620	670
4-27-56		2640	3050	2520		2620	2690
Total		3300	3850	3090		3240	3360
			ORANGE				
3-4-55	470	210	390	140		400	250
4-1-55	1360	1890	2140	1200		1820	1390
4-27-55	1920	1650	1930	1500		2060	1800
6-3-55	1450	2000	1720	1550		1760	1480
Total	5200	5750	6180	4390		6040	4920
4-9-56		1640	2950	1680		2440	1620
6-4-56		4090	2730	4380		4520	3800
Total		5730	5680	6060		6960	5420

TABLE 8. FORAGE YIELD OF CRIMSON, WHITE AND SUBTERRANEAN CLOVER VARIETIES IN SOUTHEAST TEXAS

Variety	Pounds of air-dry forage per acre				
	Kirbyville			Cleveland	Orange
	1951	1952	1956	1952	1956
Crimson clover					
Auburn	3360	4580	4650	4040	2360
Autauga	2740	4560	5020	4150	2680
Dixie	3360	4750	4250	3590	1660
Chief	3300	4740	4930	2880	2090
Talladega	3390	5470	4840	2000	1880
Common	2780	4940	4720	2400	1610
White clover					
Ladino (certified)	880	3400	1760		3520
Louisiana S-1	1300	3640	2220		3730
Louisiana	1460	2540	2190		2840
New Zealand	350	1150	1640		2220
Subterranean clover					
Tallarook	2440	4530	4280	4690	2360
Bacchus Marsh	2350	3630	4080	4380	2530
Mount Barker	2140	3220	3640	4200	2300
Nangeela	2400	3450	3960	3960	2330

the first to mature, followed in 7 to 10 days by Auburn, then Dixie and Talladega.

White Clover

White is the most desirable clover in improved permanent pastures in East Texas. Its ability to furnish grazing from late fall to early summer, the relative ease with which it can be established in a pasture and its efficiency at reseeding under heavy grazing more than compensate for its inability to survive the summer drouths and high temperatures common to most of Texas. The reseeding ability of Louisiana white and Louisiana S-1 white make them preferable to Ladino and northern sources of white clover.

Average yields of four varieties of white clover at Kirbyville, Cleveland and Orange are presented in Table 8. Louisiana S-1 produced as much or more forage than Louisiana white. When conditions favor survival, Louisiana S-1 shows greater survival than the other sources and also produces enough seed for reseeding purposes. Under such conditions, Louisiana S-1 shows greater superiority in the second than in the first year following establishment.

Subterranean Clover

Subterranean clover, with its fine-stemmed, leafy, prostrate growth, furnishes grazing from late winter to late spring. Its habit of forming seed at or just below the soil surface makes seed harvest difficult. Its seeding habit should enhance its ability to reseed under grazing. Subterranean clover often is subject to severe attacks of mildew in East Texas.

Forage yields of four varieties of subterranean clover are shown in Table 8. Yields were similar in most years. Tallarook was the highest yielding all 3 years at Kirbyville. Yields were about the same as with the reseeding crimson clover varieties. The period of production of subterranean also corresponded closely with crimson clover. Subterranean usually continued production 1 to 2 weeks later than crimson. Subterranean and crimson are similar in yield and season of production, but crimson is more easily established, therefore, subterranean has not been used extensively in the area. The dense growth produced by subterranean also is not desirable because of its smothering effects on permanent grasses.

TABLE 9. YIELDS IN POUNDS OF AIR-DRY FORAGE PER ACRE OF MISCELLANEOUS LEGUMES AT KIRBYVILLE, CLEVELAND AND NACOGDOCHES

Variety	Kirbyville		Cleveland	Nacogdoches		
	1950	1951	1950	1951	1953	1954
Singletary peas	4440	990	3080			
Persian clover	1930	1660	3590			
Madrid sweet-clover	1930	900	2100	220		
Alsike clover		1360				
California burclover		440				
Hubam sweet-clover	860			970	2260	1310
Vetch				4420	2280	2270

Miscellaneous Legumes

A large number of other legumes have been tested. Results with a few of them are presented in Table 9. Except for vetch and Singletary peas, yields are lower than with crimson, red and white clover. Vetch and Singletary peas require almost complete grazing deferment during the seed-producing period to reseed themselves.

Hop clover has not been outstanding in East Texas in yielding ability. On a comparative yield basis at Tyler in 1939, ratings were: white clover, 100; low hop, 85; Persian, 77; subterranean, 70; and least hop, 49. Only the hop clovers have

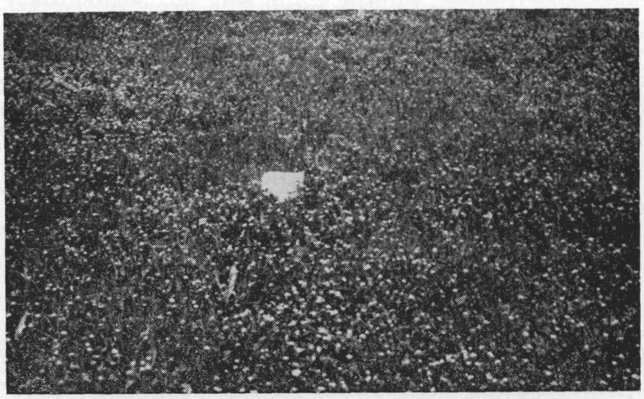


Figure 2. A stand of hop clover on Substation No. 2 at Tyler.

persisted in the test area. Hop clover is outstanding in its ability to reseed and maintain itself in sod under most fertility conditions and soil types in improved pastures in East Texas. Its fertility requirements are higher than Carolina clover, but lower than for white, red, crimson, subterranean and the Medicago species.

Sweetclover (*Melilotus sp.*) is not adapted to East Texas generally because of soil acidity (low pH), poor internal drainage in the soil and a deficiency of phosphorus and potassium. Sweetclover will grow on some soils in this area if lime and proper fertilizers are applied. This is demonstrated by the presence of sweetclover along the roadsides in some areas. Generally, however, other legumes are better adapted.

Burclover succeeds best on soils high in lime. Its quick growth and short season offer less grazing than from white clover and its overgrowth sometimes smothers grass. Because of these factors, burclovers are not generally recommended for East Texas and for areas where not already established. Where burclover is established, it should be managed to minimize the bloat problem and the effects on the permanent grass sod. Spotted burclover can be seen in East Texas in the more fertile areas around barnyards. Black medic is adapted to the redlands of the area, but not on other soil types unless limed.

Grass-Legume Mixtures

Mixtures of grasses and legumes often are suggested as a means of increasing yields, improving forage quality and extending the production period or increasing the uniformity of production. Three main annual grasses or types of plants are used in East Texas—ryegress, rescuegrass and small grains. The latter includes oats, wheat, barley, and rye. Among the legumes used are vetch, crimson, burclover and red clover. Annual sweetclover is used to some extent on heavier soils.

Table 10 shows the production of oats, ryegrass and rescue when grown in pure stands and with each of five legumes at Nacogdoches during 1953-55. Oats were the highest producing of the three grasses and vetch made the greatest contribution of the five legumes. Oats alone produced about as much forage as when grown with any one of the legumes. Vetch with ryegress and rescue produced more than either grass alone.

TABLE 10. FORAGE YIELD OF ANNUAL WINTER GRASS-LEGUME MIXTURES, NACOGDOCHES, 1953-55

Legume	Pounds of air-dry forage per acre for grass alone and grass-legume combinations			
	Oats	Ryegrass	Rescue	Average
None	4370	3480	2180	3340
California burclover	4550	2690	1720	2990
Hairy vetch	4510	3950	3570	4010
Louisiana red clover	4690	3350	2650	3560
Cogwheel	4090	3390	1950	3140
Dixie crimson	4270	3160	1860	3100
Average of each grass with all legumes	4410	3340	2320	

TABLE 11. PROTEIN CONTENT OF OAT AND RYEGRASS FORAGE AS INFLUENCED BY A LEGUME IN THE MIXTURE, LUFKIN FINE SANDY LOAM SOIL, COLLEGE STATION, 1955

Mixture	Percentage crude protein					
	March 25			April 26		
	Grass	Legume	Mixture	Grass	Legume	Mixture
Oats alone	14.2		14.2	18.3		18.3
Oats-peas[1]	19.4	33.1	25.1	23.0	36.5	23.5
Oats-burclover	16.0		16.0	20.3		20.3
Ryegrass alone	15.4		15.4	17.7		17.7
Ryegrass-peas[1]	19.0		19.0	22.2	37.7	22.2
Ryegrass-burclover	16.1		16.1	19.4		19.4

[1]Austrian winter peas.

Similar results were obtained at College Station, the main difference being that rescue usually produced more forage than ryegrass at College Station. In addition to influencing yields, legumes also may influence quality. In the College Station study, forage samples were separated into grass and legume components and the yield and crude protein content of each were determined. The legume component contributed up to 50 percent or more of the total production, but usually a very small percentage. Crude protein percentage of selected treatments in 1955 are shown in Table 11. Crude protein content was increased 2 to 5 percent in the grass component of the mixture by the presence of the legume. Increases in protein content of the total forage depended on the amount of legume growth represented in the mixture. Oat-burclover forage contained 2 percent more protein than oats alone, while oat-pea forage contained 11 percent more protein in March and 5 percent more protein in April than oats alone.

Grasses grown alone averaged 14 to 18 percent crude protein in the forage. The value of relatively small increases in crude protein at this level may be of questionable significance, especially where yields also are not increased. Where sizable increases in both yield and protein content can be obtained, such as on vetch with ryegrass and rescue, the practice of planting mixtures is valuable.

Results of these tests indicate that relatively little is gained from planting the annual legumes used in these studies with an oat variety for forage production. Adapted legumes grown in combination with ryegrass or rescue may increase total yields of both forage and protein. The foregoing results are presented from the standpoint of forage yield and quality. The possible soil improving benefits of annual winter legumes in combination with grasses are not considered.

TABLE 12. FORAGE YIELDS OF PEARL MILLET VARIETIES AND COMMON SUDAN, 1954-56

Variety	Pounds of air-dry forage per acre						
	Kirbyville				College Station		
	1954	*1955*	*1956*	Av.	*1955*	*1956*	Av.
Hybrid No. 1	6420	5580	3960	5320	3480	1250	2365
Starr	6620	3230	3950	4600	3180	1370	2275
Common	6440	4570	4190	5070	3190	1270	2230
Texas No. 7	6410	3930	4560	4970	2830	1430	2130
Common Sudan	2210	1100		1655	2740	990	1865

SUMMER PASTURE CROPS

Pearl Millet

Pearl millet (*Pennisetum glaucum*) is an annual summer grass adapted to uses similar to Sudangrass. It produces forage with a larger stalk and broader leaves than Sudan. Its performance in the Southeastern States in recent years has created interest in its adaptation to Texas conditions. Starr millet is a synthetic variety developed and released by the Georgia Coastal Plain Experiment Station and the Agricultural Research Service, USDA. Its primary advantages in the Southeast are a higher percentage of leaves and a longer season of production than Common pearl millet. Hybrid No. 1 was developed at the Georgia location from four inbred lines, but has been released only for testing purposes. Texas No. 7, a finer-stemmed but less leafy variety than Starr and Hybrid No. 1, was developed by the J. R. McNeill Seed Company at Spur.

Pearl millet should be planted in 36 to 42-inch rows on a prepared seedbed and cultivated. Row plantings should be expected to produce longer than broadcast or drill plantings. Seeding rates are 5 to 7 pounds per acre in rows and 15 to 20 pounds for close drill or broadcast plantings.

Pearl millet has been tested at a number of locations in Texas, including Kirbyville and College Station. Common Sudan was included in the tests at College Station while the yields for Common Sudan at Kirbyville were taken from near-by areas for comparison. The tests were planted in rows, cultivated and harvested at or prior to heading and as frequently as regrowth permitted.

TABLE 13. SEASONAL PRODUCTION OF PEARL MILLET AND SUDAN VARIETIES AT KIRBYVILLE, 1955[1]

Variety	Pounds of air-dry forage per acre			
	June 16	July 18	Aug. 22	Total
Hybrid No. 1 millet	770	3710	1100	5580
Starr millet	650	1720	860	3230
Common millet	1000	2710	860	4570
Texas No. 7 millet	1500	1710	720	3930
Sweet Sudan	180	980		1160
Common Sudan	180	920		1100

[1]Sudan and millet were not planted in the same test.

Total annual yields of the varieties are given in Table 12. Hybrid No. 1 had the highest average yield at Kirbyville primarily because of its performance in 1955. It was no better than the other varieties in 1954 and 1956. No yield differences were apparent at College Station.

Pearl millet produced about three times as much forage as Sudan at Kirbyville in 1954-55. Because of its poor performance, Sudan was not grown in 1956 at Kirbyville. Millet yields were slightly, but not significantly better than Sudan at College Station. In general, millet appears to be better adapted than Sudan in areas receiving relatively good rainfall and on soils low in fertility. Disease ratings are not shown, but apparently millet is less susceptible to leaf diseases than are most of the Sudan varieties. This would be an advantage particularly in East Texas and in other areas in severe disease years. Millet is not suggested as a replacement for Sudan where the performance of Sudan has been satisfactory.

Seasonal distribution of production of millet and Sudan varieties in 1955 at Kirbyville is shown in Table 13. Under Southeast Texas conditions, pearl millet starts off faster and grows longer into the summer than Sudan. Starr and Hybrid No. 1 start slower than Common millet. Hybrid No. 1 gives more production later in the season.

Sudangrass

Varieties

Sudangrass is the most commonly used annual crop for summer grazing in Texas. A large number of named varieties have been developed in breeding programs in various states and tested and grown in Texas. Since the varieties differ in leaf disease resistance, sweetness and other characteristics, a brief description of a number of the varieties follows.

Sweet Sudan (Texas S. A. 372) is a synthetic variety which originated at Substation No. 12 at Chillicothe. It has juicy stems; some resistance to foliage diseases, charcoal rot and chinch bugs; sienna glume color which makes the seed easily distinguishable from Johnsongrass seed; and shatters less than Common Sudan. It starts off more slowly than Common Sudan in the spring, but stays green later in the summer.

S-1 Sweet Sudan is a single plant selection out of Sweet Sudan by the J. R. McNeill Seed Company. It is a fine-stemmed, freely tillering sweet type.

Lahoma was released by the Oklahoma Agricultural Experiment Station as a juicy stemmed type with more disease and chinch bug resistance than most sweet types. The variety is leafy, late-maturing and has yellow to reddish-brown seed.

TABLE 14. FORAGE YIELDS OF SUDAN VARIETIES AT KIRBYVILLE AND COLLEGE STATION, 1952-56

Variety	Pounds of air-dry forage per acre								
	Kirbyville				College Station[1]				
	1953	1954	1955	Comparable average	1952	1954	1955	1956	Comparable average
Wheeler	2480	2290	1720	2160	7090	7250	5540		6280
Piper	2420	2210	2350	2330	7390	6950	5400	4760	6120
Tift	2580	1640	1350	1860	6990	6670	4580		5730
Common	2560	2210	1100	1960	8010	5740	4120	4770	5660
Sweet (372)	1780	1960	1960	1900	6910	5600	4840	4500	5460
Lahoma		2300	1700	2170	6840	5160	4830	3590	5100
Greenleaf		1820	840	1500		4770	4750	3750	4960
Sweet (S-1)	2120	1740	1160	1670	6210	3920	5060	4460	4910
Georgia 337	2080	2620		2160	6960	4200		3920	4820
No. of cuttings	2	2	2		4	5	3	3	

[1]All tests were conducted on Brazos River bottom Miller clay soil and the 1952 test received 10 inches of irrigation water

Greenleaf Sudan was released by the Kansas Agricultural Experiment Station. It has juicy stalks, leaf disease resistance and low hydrocyanic or prussic acid potential. The seed are brownish-red in color.

Wheeler Sudan was a selection of Common Sudan made on the Wheeler farm near Bridgeport, Kansas, in 1912 by the U. S. Department of Agriculture. Wheeler is a vigorous, early type, but does not have leaf disease resistance nor the juicy stem characteristic.

Piper Sudan is primarily more vigorous than Common, has a significantly lower hydrocyanic acid potential and has increased resistance to leaf blight and anthracnose. It is an early type, with mostly non-juicy stalks, that was released by the Wisconsin Agricultural Experiment Station.

Tift Sudan was developed at the Georgia Coastal Plain Experiment Station. It is disease resistant, later maturing than most other Sudan varieties and starts off slower than Common Sudan. It has a mixture of chocolate and tan colored seed and a non-juicy stalk.

Georgia 337 Sudan has excellent disease resistance, broad leaves, low hydrocyanic acid potential and is late-maturing.

Results of Sudan variety yield tests at Kirbyville and College Station are presented in Table 14. Generally, these results show that the dry-stemmed varieties, such as Wheeler, Piper, Tift and Common, are higher yielding that the juicy-stemmed types. However, there is not a wide range in total yields. The varieties differ in disease resistance which might affect quality in severe disease years. Of the dry-stemmed types, Tift and Piper might be preferred because of greater disease resistance.

Among the juicy-stemmed types, Sweet, Lahoma and Greenleaf gave good performance. These varieties have some disease resistance, with

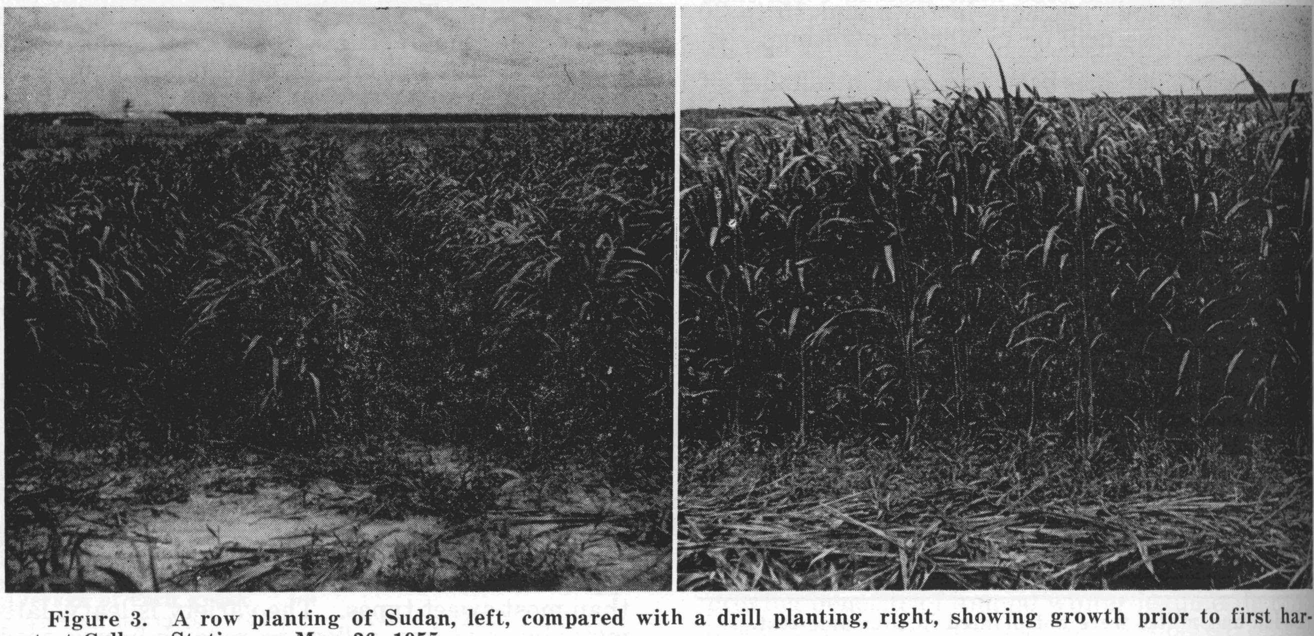


Figure 3. A row planting of Sudan, left, compared with a drill planting, right, showing growth prior to first harvest at College Station on May 26, 1955.

TABLE 15. FORAGE YIELDS OF SUDAN AS INFLUENCED BY VARIOUS RATES AND METHODS OF SEEDING ON LUFKIN FINE SANDY LOAM AT COLLEGE STATION, 1953

Seeding method	Pounds of seed per acre	Total yield in pounds of air-dry forage per acre		
		Sudan alone	Sudan-cowpeas	Average
Broadcast	20	3550	3530	3540
	30	4320	4110	4215
	40	3560	3150	3355
Average		3810	3600	3700
8-inch drill	20	4050	4110	4080
	30	4260	4130	4195
	40	4170	4010	4090
Average		4160	4080	4120
40-inch row	7	4170	4600	4385
	14	3840	4330	4085
	21	4240	4680	4460
Average		4080	4540	4310
Average for Sudan alone and with cowpeas		4020	4070	4040

Greenleaf and Lahoma possibly being more resistant than Sweet. Observations indicate that Greenleaf is affected more by drouth than Sweet and Common.

Method and Rate of Seeding

Results of seeding Sudan alone and with cowpeas at three different rates and by three different methods are given in Tables 15 and 16. No significant differences occurred in total yield for the season among rates or methods of seeding. Cowpeas had no significant influence on the total yield of forage. There was a significant difference in yield among methods of seeding at each harvest date (Table 16). The broadcast and drill plots produced three times as much forage at the first harvest as the 40-inch row plots. The 40-inch row plots produced almost twice as much forage as the broadcast and drill plots at each subsequent harvest. The total seasonal yields for all planting methods amounted to about the same, with the 40-inch plots being slightly higher. Figure 3 shows the growth in drill and row planting in 1955 prior to first harvest in May.

The study was altered in 1954 by eliminating cowpeas and cultivating the 40-inch row. Seasonal distribution of yield was similar to that obtained in 1953 with close-drill plantings (8-inch rows) behaving like broadcast. Cultivation increased yields in the 40-inch rows.

Results of a similar study conducted in 1955-56 on Lufkin fine sandy soil with irrigation are shown in Table 17. A better distribution of production was obtained with both row and broadcast seedings. Good production was maintained into September, indicating that the main factor causing reduced summer production of Sudan is limited moisture. Total production was greater from row than from broadcast plantings and the late summer production held up better in row plantings. The best yield was obtained with 14 pounds of seed in rows. No difference in yield due to seeding rate was obtained on dryland. Yields in broadcast stands were increased up to the maximum seeding rate of 50 pounds per acre. Yield increases were small, but were significant statistically. These results indicate that more plants are needed for maximum production when moisture conditions are good.

A study conducted at Mt. Pleasant (Table 18) in 1954-55 indicates a slight advantage in total yield for broadcast seeding of Sudan. There was no yield difference attributable to cowpeas in the mixture. These plantings were made in late May or early June, which resulted in lower yields than might be expected from earlier plantings. Nitrogen was included as another variable, but there was little opportunity for response because of late planting and shortage of moisture. Nitrogen usage and response depend largely on the amount of available moisture.

Broadcast plots not only yielded somewhat more than row seedings, but the seasonal distribution also was about the same. This is in contrast with results at College Station where the main difference in the two seeding methods is in the distribution of forage production. The advantage in row seedings probably is great enough to more than offset the small yield difference. Row seedings result in less trampling by grazing animals and facilitate cultivation for weed control, irrigation and sidedressing with fertilizer.

Crude protein and phosphoric acid content of the forage for the first three harvest dates in 1953 at College Station are given in Table 19. High quality forage was produced throughout the growing season. There was very little influence of treatments on forage quality. The average crude protein content of the Sudan-cowpea mixture was significantly higher than that of Sudan alone at the first harvest. Forage from row seedings contained significantly more protein and

TABLE 16. SEASONAL YIELDS OF SUDAN AS INFLUENCED BY METHOD OF SEEDING ON LUFKIN FINE SANDY LOAM AT COLLEGE STATION, 1953

Seeding method	Pounds of air-dry forage per acre							
	May 28		June 24		July 16		Sept. 11	
	Sudan alone	Sudan-cowpeas	Sudan alone	Sudan-cowpeas	Sudan alone	Sudan-cowpeas	Sudan alone	Sudan-cowpeas
Broadcast	2480	2420	480	380	320	290	530	510
8-inch drill	2660	2730	510	500	420	350	560	500
40-inch row	860	760	1420	1760	890	910	910	1100
Average	2000	1970	800	880	540	520	670	700

TABLE 17. FORAGE YIELDS OF IRRIGATED SUDANGRASS GROWN ON LUFKIN FINE SANDY LOAM SOIL WITH VARIOUS SEEDING RATES AND METHODS, 1955-56

Seeding method	Seeding rate, pounds per acre	Pounds of air-dry forage per acre					
		May	June	July	Aug.	Sept.	Total
40-inch cultivated row	7	925	1445	1190	1190	800	5550
	14	1240	1515	1260	1810	1015	6840
	21	1240	1395	1320	1620	1000	6575
	28	1255	1405	1120	1250	990	6020
Average		1165	1440	1220	1470	950	6245
Broadcast	20	1015	1390	830	1015	750	5000
	30	1035	1530	760	930	695	4950
	40	1345	1505	790	1060	820	5520
	50	1425	1695	775	1195	685	5775
Average		1205	1530	790	1050	740	5315

phosphoric acid than did broadcast seedings at the first harvest and significantly less at the second harvest. These results are related directly with yield since row seedings were lower in yield at the first harvest and higher in yield at the second harvest. The direct influence of treatments on chemical composition is not sufficient to influence the selection of a method or rate of seeding.

Results of the seeding studies suggest that broadcast and drill plantings are satisfactory for hay production. For grazing purposes, where distribution of production throughout the growing season is important, row seedings are the most dependable. This is true whether the plantings are on irrigated or dryland. Row seeding rates of 7 to 10 and 10 to 15 pounds per acre on dryland and with irrigation, respectively, give the best results. Twenty pounds per acre broadcast are satisfactory on dryland, with possibly more seed being needed with irrigation. The use of cowpeas with Sudan does not improve yield or quality appreciably.

Perennial Sorghums

Sorghum almum and Perennial Sweet Sudan should be planted in rows, cultivated and managed as Sudan. These crops have not been tested extensively, but apparently they perform about the same as annual Sudan. Yields are reported in Table 20 for Sorghum almum, Perennial Sweet Sudan, Sweet Sudan and Common Sudan. Yields

TABLE 18. FORAGE YIELD OF SUDANGRASS WITH VARIOUS SEEDING METHODS AND MIXTURES, MT. PLEASANT, 1954-55

Mixture	Seeding method	Pounds of air-dry forage per acre		
		1954	1955	Average
Sudan alone	Row	1200	2450	1825
	Broadcast	1670	3460	2565
Average		1435	2955	2195
Sudan with cowpeas	Row	1390	2910	2150
	Broadcast	1560	3540	2550
Average		1475	3225	2350

were slightly, but not significantly higher for the perennial types. Some plants of Sorghum almum and Perennial Sweet Sudan survived to the second and succeeding years. In an area near this test, second-year Sorghum almum produced 880 pounds of forage in May before the spring-planted test had started producing. The second-year test produced an average of 5,780 pounds of forage per acre, which is about the same as the first-year material produced. However, this test had been managed for hay in 1956 and seed had been produced in the fall of 1956. Thus, much of the production in 1957 was from volunteer plants. These studies were conducted on Brazos River bottom Miller clay soil. Previous observations indicate that on shallow soils and under grazing, survival of the perennial types is likely to be poor.

In a study at Tyler in 1957, Sorghum almum produced 2,780 pounds of air-dry forage per acre; Perennial Sweet Sudan, 2,860; Common Sudan, 2,340; and Sweet Sudan, 3,410. Yearling Jersey heifers, grazing a part of the test area, showed a preference for the sweet types with no discrimination between Common Sudan and Sorghum almum.

Perennial Summer Grasses

The two main perennial pasture grasses in East Texas are Bermuda and Dallisgrass. Other grasses, such as carpet and Bahia, are adapted and will grow in this area, but are less desirable than Bermuda and Dallis.

Bermudagrass is native to the Mediterranean region and Southern Asia, but is now common throughout the Cotton Belt where it is considered as native by stockmen and farmers. Bermuda is a long-lived perennial with spreading habit of growth, reproducing by runners, rootstocks and seed. The runners vary in length from a few inches to 3 or 4 feet, and the seed stalks usually attain a height of 6 to 12 inches or more, depending on soil productivity. Bermuda will grow on almost any soil type, but does the best on well-drained, fertile loam and sandy loam soils.

Many varieties and strains of Bermudagrass have been developed and introduced. The most important of these is Coastal which is a hybrid

TABLE 19. CRUDE PROTEIN AND PHOSPHORIC ACID CONTENTS OF SUDAN FORAGE WITH VARIOUS RATES AND METHODS OF SEEDING ON LUFKIN FINE SANDY LOAM AT COLLEGE STATION, 1953

Seeding method	May 28		June 24		July 16		Season average		
	Sudan alone	Sudan-cowpeas	Sudan-alone	Sudan cowpeas	Sudan alone	Sudan-cowpeas	Sudan alone	Sudan-cowpeas	Aver-age
	Percent crude protein								
Broadcast	14.1	15.2	14.6	14.2	13.6	14.3	14.1	14.6	14.3
40-inch row	17.6	17.7	11.9	11.9	14.6	14.6	14.7	14.8	14.8
Average	15.9	16.5	13.3	13.1	14.1	14.4	14.4	14.7	14.6
	Percent phosphoric acid								
Broadcast	.57	.66	.32	.34	.42	.43	.44	.47	.46
40-inch row	.72	.72	.28	.32	.44	.46	.48	.50	.49
Average	.64	.69	.30	.33	.43	.44	.46	.49	.48

produced at the Georgia Coastal Plain Experiment Station from a cross between Tift Bermuda and a strain introduced from South Africa. Coastal differs from Common in that it produces stems, stolons and rhizomes which are larger and have longer internodes than Common. It is characteristically light green in color and, in contrast with Common, produces very few seed heads which contain few, if any, viable seed. Its taller growth makes Coastal much better adapted to hay making than Common.

Other strains of Bermuda include Suwannee, Selection No. 3 and Midland. Suwannee and Selection No. 3 were developed in Georgia at the same time as Coastal. Suwannee was released in Georgia for use on deep sands where its efficiency of nitrogen recovery is greater than Coastal. It has not been tested adequately in Texas to determine its value. Selection No. 3 has finer stems, shorter internodes and produces a denser ground cover, but it was found to be less palatable than Coastal in Georgia. Its yield at Mt. Pleasant was greater than Coastal, but this may not be as important as growth habit and palatability. Midland is a cold-hardy strain developed in Georgia from a cross between Coastal and a hardy variety from Indiana. It was released in Oklahoma for use where Coastal is not winter-hardy. It has no advantages over Coastal where Coastal is winter-hardy.

Dallisgrass is a perennial, warm-season grass that grows in clumps. Most of the leaves are produced near the base of the plants on shoots that arise from the knotty base of extremely short rhizomes. The seedstalks are 2 to 4 feet high and drooping to nearly prostrate except when supported by other plants. Dallisgrass is one of the first plants to begin growth in the spring and one of the last to cease growth in the fall. It is adapted to a range of soils from clay to sandy loam, but does best on moist clay and loam soils high in organic matter. It does not do well on sandy or alkaline soils, or on soils low in organic matter and fertility. Dallisgrass 430 from Louisiana is the only named strain available in the United States.

Forage yields for four grasses at Kirbyville are given in Table 21. Coastal Bermuda produced the highest yields during the 2 years of this test. Rhodesgrass produced as much as Coastal the first year and was second in production the second year. Rhodes is relatively short-lived in contrast with the other species and tends to decrease in production each year. Dallisgrass produced more than Common Bermuda, however, Dallisgrass is seldom found growing in pure stands.

Results of a Bermudagrass strain test at Mt. Pleasant are presented in Table 22. Other experimental strains were grown in the test but none produced as much as those shown. Coastal produced 50 percent more forage than Common in this test and 32 percent more than Common at Kirbyville. Results elsewhere in the State have ranged from 20 percent upward in favor of Coastal. Selection No. 3 produced 25 percent more than Coastal at Mt. Pleasant. As pointed out earlier, it has a shorter internode length and denser growth, making it less desirable for hay production. Most of the extra production comes in late April, May and early June, which is not as important as production in July and August. Because of the less desirable growth habit and lower palatability of Selection No. 3, it has not been increased for use in Georgia where it was developed.

A Bahiagrass strain test was conducted at Kirbyville in 1955. Pensacola and Argentine were the highest producing strains, averaging 6,590 and 5,750 pounds of air-dry forage per acre, respectively. Bahia strains have not been tested

TABLE 20. FORAGE YIELD OF SORGHUM SPECIES AT THE A&M PLANTATION, 1957[1]

Variety	Pounds of air-dry forage per acre				
	June 12	July 8	Aug. 8	Oct. 28	Total
Perennial Sweet Sudan	2570	1030	1080	810	5490
Sorghum almum	2920	900	1040	640	5500
Sorghum almum (Australia)	2610	1020	990	480	5100
Sweet Sudan	2450	1180	1040	420	5090
Common Sudan	2550	1300	1000	490	5340

[1]Plots established April 11, 1957

TABLE 21. FORAGE YIELD OF PERENNIAL GRASSES AT KIRBYVILLE, 1953-54

Species	Pounds of air-dry forage per acre		
	1953	1954	Average
Common Bermuda	4240	4220	4230
Dallis	6740	4460	5600
Rhodes	7200	4790	5995
Coastal Bermuda	7210	5520	6365

TABLE 22. FORAGE YIELD OF THREE BERMUDA-GRASS STRAINS AT MT. PLEASANT ON DEEP SANDY SOIL, 1952-55

Strain	Pounds of air-dry forage per acre				
	1952	1953	1954	1955	Average
Common	860	9620	3600	4540	4660
Coastal	1330	13390	6880	6340	6980
Selection No. 3	2650	17150	8000	7270	8770

elsewhere in East Texas. Bahia has survived in the grass nursery at College Station for several years, but it is one of the first species to be affected by drouth. In general, Bahia is not considered a desirable grass for this area.

Bermuda, Dallis, carpet and Bahia predominate on the improved pastures at the Lufkin pasture laboratory. The laboratory includes 143 acres of improved pastures and 68 acres of woodland and unimproved pastures. Average acre production on this land for a 6-year period is shown in Table 23. Total carrying capacity in 1954 was 911 pounds of live weight per acre of improved pasture, or 627 pounds of live weight per acre on the entire laboratory. The carrying capacity in 1957 was 1,014 pounds of liveweight per acre of improved pasture, or 705 pounds per acre on the entire laboratory. The improved pasture acreage produces most of the forage. The pasture improvement program consisted of overseeding such legumes as white, hop and crimson clover in the permanent grasses along with an annual fertilization program. Figure 4 shows the types of vegetative cover obtained with this program. On upland pasture, the fertilization program consisted of 60 pounds of phosphoric acid and potash and 20 to 50 pounds of nitrogen per acre annually. The creek bottom pastures received 70 pounds of phosphoric acid, 35 pounds of potash and 50 to 100 pounds of nitrogen per acre annually. Since 1954, the fertilization program has been based on soil test analysis and has been less in some years than that indicated.

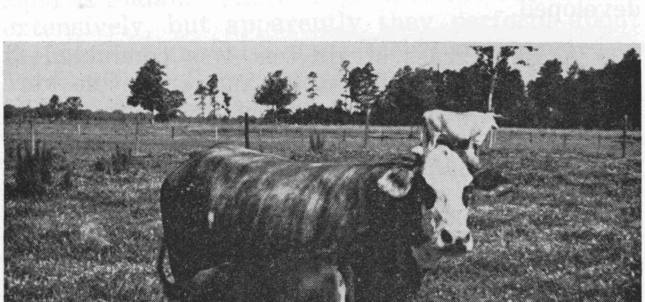


Figure 4. Plant growth and ground cover on pastures at the Lufkin Pasture Laboratory, May 1946.

Grass-Legume Mixtures

The use of perennial grasses and annual winter legumes shows promise of increasing total forage production and lengthening the season of production. Results of a grass-legume mixture study at Kirbyville are presented in Table 24. Coastal Bermuda produced the most forage and Common Bermuda the least of the grasses in the test. Total yields were increased to some extent with each legume. The use of crimson clover, red clover and a mixture of all legumes with the grasses resulted in the greatest total production. The plots were clipped 10 times in 1953, beginning March 12, and seven times in 1954, beginning February 28. With this clipping procedure, only white and subterranean clover reseeded satisfactorily. Since none of the legumes survived through the summer, most of them would have to be established annually either through natural reseeding or planting. White and subterranean normally would produce enough seed under grazing to insure reestablishment. Crimson clover should be deferred from grazing a few weeks during the seed-producing season to insure reseeding. Alfalfa and red clover are not considered natural reseeding types. An example of the plant association for Dallisgrass and white clover is shown in Figure 5.

Individual clipping data for Coastal-legume mixtures in 1954 are shown in Table 25 to demonstrate the effect of legumes on season of production. February production was best with alfalfa, while March production was better with crimson and red clovers. All legumes increased total production in April, while the effects of crimson and red clover carried over into May.

TABLE 23. PRODUCTION OF IMPROVED PASTURES ON THE EAST TEXAS PASTURE INVESTIGATION LABORATORY AT LUFKIN, 1951-56

Year	Average pounds of calves weaned per acre	Average bales of hay saved per acre	Annual rainfall inches[1]
1951	106	7	35.38
1952	170	15	43.95
1953	185	52	55.09
1954	244[2]	6	28.96
1955	221	20	42.86
1956	203	8	31.77

[1]Average rainfall 48.67 inches.
[2]Includes 33 pounds of net gain on steer yearlings purchased for spring grazing.

TABLE 24. FORAGE YIELDS OF GRASS-LEGUME MIXTURES ON BOWIE FINE SANDY LOAM AT KIRBYVILLE, 1953-54

Legume	Pounds of air-dry forage per acre[1]				
	Coastal Bermuda	Common Bermuda	Dallis-grass	Rhodes-grass	Legume average
None	6360	4230	5600	6000	5550
Crimson clover	9020	6760	6350	7340	7370
Red clover	9540	6520	6140	7210	7350
White clover	7910	6020	6000	7220	6790
Subterranean clover	9290	6820	5940	6000	7010
Alfalfa	8300	5680	5990	6390	6590
Mixture[2]	9640	6640	6160	6840	7320
Grass average	8580	6100	6020	6710	

[1] Harvested March 12, March 24, April 13, May 7, May 26, June 11, July 1, July 16, Aug. 7 and Sept. 1, 1953; Feb. 25, March 29, April 26, May 28, June 22, July 22 and Oct. 14, 1954.

[2] Mixture of all six legumes.

None of the legumes gave any further increase in production after May. The increased production in February, March and early April should be valuable in a pasture production program since it comes at a time when green forage is likely to be limited.

A study was started early in 1955 to determine the influence of various legumes in contrast with applied nitrogen on total and seasonal production of Coastal Bermuda. The legumes were overseeded on Coastal each fall. Split applications of nitrogen were started on the nitrogen plots in early spring. The results, Table 26, demonstrate the value of growing winter legumes with Coastal, which does not begin growth until mid-April in this area. Total production was increased remarkably by most of the legumes. The use of 60 pounds of nitrogen per acre gave more total production in 1956 than most of the legume-Coastal combinations. Several of the legume-Coastal combinations produced more in 1955 than Coastal with nitrogen. Early production was increased most by crimson clover and narrowleaf vetch. Total production was increased most by narrowleaf vetch and nitrogen.

TABLE 26. FORAGE YIELD OF COASTAL WITH VARIOUS ANNUAL WINTER LEGUMES AT MT. PLEASANT, 1955-56

Legume or treatment	Pounds of air-dry forage per acre			Average % of total produced by April 20
	1955	1956	Average	
None	1150	900	1025	6
Nitrogen[1]	4090	3720	3905	2
Crimson clover	4390	1390	2890	46
Hop clover	3760	2340	3050	22
Singletary peas	4760	1720	3240	30
Narrowleaf vetch	4970	3270	4120	38

[1] Sixty pounds per acre.

Narrowleaf vetch (*Vicia augusifolia*) is a native plant in East Texas and has been tried earlier under cultivation without success. It shows some promise when used on permanent sod. Deferred grazing during the seed-producing season is not necessary to insure reseeding since other plants are more palatable at that season. Commercial seed supplies are not available at this time, but seed in small quantities may be obtained from native stands.

Figure 5. A mixture of Dallisgrass and white clover in plots at Kirbyville on Bowie fine sandy loam soil.

TABLE 25. FORAGE YIELD OF COASTAL BERMUDA-CLOVER MIXTURES AT KIRBYVILLE ON BOWIE FINE SANDY LOAM, 1954

Legume	Pounds of air-dry forage per acre							
	Feb. 25	Mar. 29	Apr. 26	May 28	June 22	July 22	Oct. 14	Total
None	90	280	960	660	1560	790	1180	5520
Crimson clover	220	1480	1730	530	1710	890	1410	7970
Red clover	130	1400	1510	1780	1480	940	1610	8850
White clover	180	550	1490	1160	1310	930	1710	7330
Alfalfa	460	620	1180	920	1630	900	1420	7130
Subterranean clover	320	870	1660	490	1990	1060	1730	8120
Mixture[1]	300	870	1560	870	1690	960	1780	8030

[1] Mixture of all five legumes.

TABLE 27. EFFECT OF FERTILIZER ON THE FORAGE YIELD OF A PASTURE MIXTURE ON AN UPLAND SOIL, LUFKIN, 1949-53[1]

Treatment, pounds per acre per year			Pounds of hay (14% moisture) per acre			
N	P_2O_5	K_2O	1940-50	Increase over check	1951-53	Increase over check
0	0	0	2430		2660	
0	60	0	3270	840	4490	1830
0	60	60	3550	1120	5880	3220
60	0	0	3150	720	3090	430
60	60	0	4870	2440	4940	2280
60	60	60	5150	2720	5670	3010
90	0	0	4010	1580	4070	1410
90	60	0	5270	2840	5430	2770
90	60	60	5890	3460	5730	3070

[1]The pasture mixture consisted of Bermuda, Dallis and carpet grasses and white clover.

Permanent Pasture Fertilization

Fertilizer studies have been conducted at a number of locations in East Texas, including Kirbyville, Lufkin, Nacogdoches, Tyler and Mt. Pleasant. A significant response to fertilizer applications generally is obtained. The type of response may vary with locations and species or species combinations and may change with time.

A study was conducted on upland soil at Lufkin during 1949-53 using Bermuda, Dallis and carpetgrass and white clover. Results of the study are summarized in Table 27. During the first 2 years of the study, the yield response was to nitrogen, phosphorus and potassium, while during the final 3 years the yields with phosphorus and potassium were as good as when nitrogen, phosphorus and potassium were applied. These results suggest that a sound fertilization program for a permanent grass-annual legume combination would be a complete fertilizer for the first 2 years. In succeeding years, a basic application of phosphorus and potassium should be made, followed by the use of summer nitrogen applications when moisture is adequate. During the first 2 years, while the fertility level is being built up, the nitrogen applications should be timed to allow the legume to become established and to produce a seed crop. It may be desirable to reduce the amount of nitrogen in the second year to encourage the legume.

Work at both Lufkin and Nacogdoches shows the greatest net profit from the use of 90-60-60 fertilizer the first 2 years. The greatest net return after the first 2 years at Lufkin was with a 0-60-60 fertilizer. As the fertility level improved, legumes, which required no fertilizer nitrogen and which supplied some nitrogen to the associated grass, increased in the mixture. These treatments were on different plots. If the nitrogen applications were not timed, especially after the first year, the desired legume growth might not be obtained.

A study was conducted on Caddo fine sandy loam soil at Kirbyville in 1950-51 to determine the influence of seedbed preparation and fertility on establishment and production of a number of introduced grasses and legumes on a native sod. The grasses included Bermuda, Dallis and carpet, seeded in a mixture of pure grasses and with a mixture of legumes. The legumes included white, hop and Persian which were seeded with the grasses and also in a pure stand of legumes.

Seedbed preparation influenced the stand of the introduced grasses, but not the legumes. However, seedbed preparation had relatively little influence on yields since the native sod, where it

TABLE 28. FORAGE YIELD OF COASTAL AND SELECTION NO. 3 BERMUDA AT DIFFERENT NITROGEN LEVELS, MT. PLEASANT, 1955-56

Nitrogen, pounds per acre[1]	Pounds of air-dry forage per acre			Pounds of forage per pound of nitrogen applied
	Coastal	Sel. No. 3	Nitrogen average	
0	1580	1430	1500	
30	2470	2830	2650	38
60	3950	4520	4240	46
90[2]	5250	5990	5620	46
120	6120	6390	6260	40

[1]All plots received 0-60-60 annually.
[2]These plots received 8 tons of manure per acre December 14, 1954.

TABLE 29. FORAGE YIELD OF SELECTION NO. 3 BERMUDA WITH DIFFERENT LEVELS OF NITROGEN AND POTASH, MT. PLEASANT, 1953-55

Nitrogen, pounds per acre	Pounds of air-dry forage per acre			Pounds of forage per pound of nitrogen applied
	Pounds of potash per acre		Nitrogen average	
	0	60		
0	2840	2440	2640	
30	3950	5340	4645	66
60	5950	6150	6050	57
Potash average	4250	4640		

TABLE 30. FORAGE YIELD OF COASTAL BERMUDA GROWN ALONE AND WITH NARROWLEAF VETCH AT MT. PLEASANT, 1956

Treatment	Pounds of air-dry forage per acre				
	March-April	May-June	July-August	Sept.-October	Total
Coastal + nitrogen	60	1440	1540	870	3910
Coastal + vetch	1560	900	920	740	4120

was not destroyed, produced about as much as the introduced grasses. In pure grass stands, the maximum yield was 4,220 pounds per acre of air-dry forage with a 60-120-60 fertilizer, as compared with 1,400 pounds with no fertilizer. Legume yields were increased from 1,360 to 5,380 pounds per acre with a 0-120-60 fertilizer. Where both grasses and legumes were overseeded, yields were 5,450 pounds per acre with a 60-120-60 fertilizer, as compared with 4,590 pounds with a 0-120-60 fertilizer. These data indicate that good yields can be obtained through the use of legumes and phosphorus and potassium. Had this study been continued for as long a period as the Lufkin study, yields of the mixture without nitrogen would no doubt have compared more favorably with the complete fertilizer plots.

The response of two Bermudagrass varieties grown in pure stands to fertilizer treatments has been studied at Mt. Pleasant. Tables 28 and 29 indicate a significant response to nitrogen applications and a smaller response to potash. Each additional 30 pound increment of nitrogen further increased yields. The response per pound of nitrogen was not as great at the upper as at the lower limits. The amount of nitrogen to which a response can be obtained with Bermuda depends largely on available moisture.

The difference in time of forage production of a grass-legume mixture and a grass receiving

TABLE 31. FORAGE YIELDS OF LEGUMES AS INFLUENCED BY FERTILIZERS AND LIME AT NACOGDOCHES, 1951-54

Species	Lime	Pounds of air-dry forage per acre			
		Fertilizer treatment			
		0-0-0	0-42-21	30-90-120	Average
Vetch	Lime	3170	4060	4040	3760
	No lime	2610	3590	4690	3630
Crimson clover	Lime	2830	3640	3930	3470
	No lime	2680	3210	4070	3320
Hubam sweetclover	Lime	1210	1510	2110	1610
	No lime	910	1100	1890	1300
Austrian Winter peas	Lime	1440	1800	2410	1880
	No lime	1370	1700	2160	1740
Red clover	Lime	1450	2260	2660	2120
	No lime	1310	1810	2460	1860
Average		1900	2470	3040	

TABLE 32. INFLUENCE OF CULTIVATION AND RENOVATION ON BERMUDAGRASS AT MT. PLEASANT, 1956

Treatment	Pounds of air-dry forage per acre		
	May 22	July 12	Total
No treatment	260	80	340
Cultivated	280	90	370
Fertilized[1]	1120	620	1740
Cultivated and fertilized[1]	1120	460	1580

[1]Fertilizer was 90-60-60, with nitrogen applied in 30-pound increments, April 5, May 22, July 12. Only 1 inch of rain after May 2.

nitrogen is demonstrated in Table 30. Yields of the two treatments are essentially the same, yet the time of production is vastly different. The legume increased production in early spring, while nitrogen increased production in mid-summer. The extent of response of either of these treatments is influenced by moisture and availability of other nutrients. A treatment combining a legume with summer nitrogen applications was not tested, but theoretically should produce more than either of these treatments.

Through the use of ample phosphorus and potash, annual legumes can be encouraged to grow with perennial grasses. However, as the nitrogen level is increased, the percentage of legume in the mixture will, in general, be decreased. On soils low in fertility, some nitrogen on legumes may be worthwhile to support plant growth until nodulating bacteria have started functioning.

Results of a fertilizer test at Nacogdoches involving pure stands of legumes are presented in Table 31. While it is not possible in this test to attribute increased growth to any particular element in the fertilizer, it is apparent that fertilizer did increase growth. Vetch and crimson clover were the highest yielding. Huban sweetclover and red clover showed the greatest percentage increase in yield due to lime, amounting to 24 and 14 percent, respectively. The highest percentage increase with 0-42-21 fertilizer treatment was 56 percent with red clover. Vetch and crimson clover showed 28 and 29 percent increases, respectively, with the same treatment.

Cultivation

Cultivation of perennial pastures has been practiced as a means of aeration, improving water penetration and placing fertilizer in the soil in permanent sod. Studies in East Texas and other parts of the State indicate that this is not necessarily a beneficial practice. Results of a study at Mt. Pleasant (Table 32) show that production was no higher with cultivation than with no cultivation, and that cultivation with fertilization was no better than fertilization alone. Fertilization did increase production. A similar type of response was obtained in a study conducted at the Blackland Experiment Station at Temple, Station Progress Report 1777. Renovation of bottomland pastures at the Lufkin Pasture Laboratory resulted in slightly decreased yields for 3 years following renovation. Renovation was by means of chisels spaced 19 inches apart and run about 8 inches deep.

In all of these studies, renovation was done by means of chisels with the fertilizer broadcast on the surface following cultivation. No results are reported of fertilizer being placed in the soil at the time of cultivation.

Establishment

General procedures for establishing pastures in East Texas are given in Extension Bulletin 197, "Building Pastures." On cultivated loamy and sandy soils, the planting of Bermudagrass seed normally is not necessary. As soon as the soil is conditioned or improved with organic matter and plant food, a good stand of Bermuda will develop naturally. The quickest method of developing a good stand of Bermuda is through the growing of annual legumes, fertilized according to soil test recommendations. The legumes should be allowed to grow to maturity.

Results of Dallisgrass etsablishment studies are reported in Station Bulletin 829, "Dallisgrass." Seed quality in Dallisgrass is a major problem and often is the cause of stand failure. To establish Dallisgrass on cultivated land, good quality seed should be planted on a well-prepared seedbed in late winter or early spring. On extremely weedy soils, weed competition is reduced by fall seeding oats in 18 to 21-inch rows and introducing Dallisgrass seed between the rows during late winter.

Results of an establishment study at Kirbyville involving both grasses and legumes are reported in Station Progress Report 1918. This study involved the amount of seedbed preparation necessary to establish introduced plants in native sod. It was found that Bermuda, Dallis and carpetgrass require good seedbed preparation for satisfactory establishment, and that added fertilizer is not a substitute for seedbed preparation. Legume establishment was satisfactory on all plots, but growth was best on plots receiving liberal amounts of phosphorus and potassium.

HAY CROPS

Annual Crops

Annual crops have been used to some extent for hay in East Texas. Summer legumes, such as cowpeas, alyceclover and lespedeza, make good quality hay, but yields are low. The highest yields at Kirbyville in 1950 were produced by Iron cowpeas and alyceclover and amounted to about 3,200 pounds of hay per acre (Table 33). Cowpeas produced about 1,000 pounds of hay per acre at Mt. Pleasant in 1955.

Annual grass crops, such as Sudan and Pearl millet, produce more total forage than annual legumes, but the grass forage is of a lower quality. Results of yield studies with the annual grasses are presented in Tables 12, 14 and 16. Data collected at the A&M Plantation near College Station and at Prairie View in 1953 show that Sudan in the hay stage contains 10 to 13 percent crude protein and Chinese Red cowpeas contain 14 to 19 percent. Phosphoric acid content also was higher in cowpea forage than in Sudan forage. Crude protein percentages reported in Table 19 for Sudan range from 11.9 to 17.7, but the forage was in a younger stage than normally would be cut for hay.

Perennial Crops

Yield results have been presented for perennial grasses managed as pasture plants. Coastal Bermuda produced an average of 6,980 and 6,365 pounds of air-dry forage per acre at Mt. Pleasant and Kirbyville, respectively. These yields were produced with no irrigation and fertilizer applications of 110-40-40 annually at Mt. Pleasant and 120-60-30 annually at Kirbyville. Much higher yields have been obtained at other locations with heavy fertilizer applications and irrigation.

Coastal Bermuda

Results of a fertilizer study on Coastal Bermuda at College Station are reported in Station Progress Report 1837. Nitrogen treatments up to 1,350 pounds per acre were used. Each nitrogen level was split into five applications with the maximum amount per application being 225 pounds at the 1,350-pound per acre level. Yields in 1954 ranged from 3 tons per acre of hay with no nitrogen to 12.7 tons with 800 pounds of nitrogen, which was the top rate in 1954. Yields in 1955 ranged from 2.4 tons per acre of hay with no nitrogen to 14.5 tons with 1,350 pounds of nitrogen. A yield of 13 tons of hay was produced with 750 pounds of nitrogen in 1955. Forty-four inches of irrigation water were applied in 1954 and 27 inches in 1955. Rainfall during the growing season brought the totals up to 58 inches in 1954 and 42 inches in 1955. Thus, 3 to 5 acre-inches of water were used to produce a ton of hay at the higher nitrogen levels.

A 3-year study with Coastal was conducted at Homer, Louisiana, on Lakeland sand without irri-

TABLE 33. YIELD OF OVEN-DRY FORAGE OF SUMMER LEGUMES AT KIRBYVILLE, 1950

Variety or species	Date of harvest	Yield, pounds per acre
Iron cowpeas	9-5-50	3250
Alyceclover	9-18-50	3200
Guar	9-5-50	2540
Chinese Red cowpeas	8-14-50	2290
Korean lespedeza	9-5-50	1980

gation.[1] Nitrogen rates of 0, 200, 400 and 600 pounds per acre were used in split applications with a maximum of 200 pounds in one application. A linear yield response was reported from applications of nitrogen up to 400 pounds per acre. The forage yields ranged from 1,400 pounds with no nitrogen to 13,500 pounds per acre with 400 pounds of nitrogen. The 600-pound nitrogen application produced 14,000 pounds of forage per acre, which was not significantly different from the yield obtained from the 400-pound application.

Pastures

These data indicate the potential production of a perennial grass such as Coastal when managed for hay. The yields are totals resulting from three to five cuttings. Some indication of the possibilities of hay production from improved pastures is shown in Table 23. An average of 25 bales of hay per acre was produced on the Lufkin Pasture Laboratory during 1951-53. This amounts to slightly less than 1 ton of hay per acre harvested from pastures which were supporting as much as 911 pounds of cattle weight per acre. In a permanent pasture system, it is desirable during a period of flush growth that a part of the pasture be deferred from grazing to make hay or silage. This plan was followed at Lufkin. Figure 6 shows a Bermudagrass pasture being harvested for hay.

[1]Johns, Dawson M., Wilcox, G. E., Russel, D. A., and Halob, A. Coastal Bermuda response to nitrogen fertilization in North Louisiana. Proceedings of the 54th annual Southern Agricultural Workers, 84-85, 1957.

TABLE 34. THE INFLUENCE OF FERTILIZER ON YIELD AND QUALITY OF LITTLE BLUESTEM HAY AT TYLER, 1952-55

Treatment	Average hay yields, pounds per acre		Average percentage	
	1952-54	1955[1]	Crude protein	Phosphoric acid
0-0-0	2150	2950	5.27	.26
40-0-0	3400	2560	5.44	.22
80-0-0	5230	3620	6.23	.18
120-0-0	5810	5700	7.44	.19
Average	4150	3710	6.09	.21
0-40-0	2910	3660	5.54	.35
40-40-0	4160	3100	5.29	.34
80-40-0	6100	3590	6.35	.27
120-40-0	7410	4900	6.84	.29
Average	5140	3820	6.01	.31
0-0-40	2430	3110	5.46	.26
40-0-40	3670	3090	5.33	.22
80-0-40	5210	3700	6.46	.19
120-0-40	5620	5050	7.17	.19
Average	4230	3740	6.11	.22
0-40-40	2240	3310	5.30	.33
40-40-40	4400	3390	5.64	.31
80-40-40	5810	3730	6.02	.31
120-40-40	6710	3640	7.44	.30
Average	4790	3520	6.10	.31
(0-40)-40-40	3260	5030		
(40-40)-40-40	5730	5010		
(60-60)-40-40	6230	4830		
Average	5070	4960		

[1]No fertilizer was applied in 1955.

Figure 6. Harvesting Bermudagrass hay from a pasture on Substation No. 2 at Tyler.

Native Meadows

Native meadows also may be used for hay. Through fertilization, they can be made very productive. Little bluestem (*Andropogon scoparius*) occupies considerable acreage in the northern part of East Texas as well as in the Blacklands and on the Grand Prairie. A little bluestem meadow, typical of those in this area, is shown in Figure 7. Most of the hay sold as "prairie hay" in this area consists of little bluestem, with some mixtures of other bluestems and native grasses. The forage quality of these bluestems is determined by available plant nutrients and harvest management. Even well-fertilized crops will deteriorate rapidly in quality as seed formation progresses.

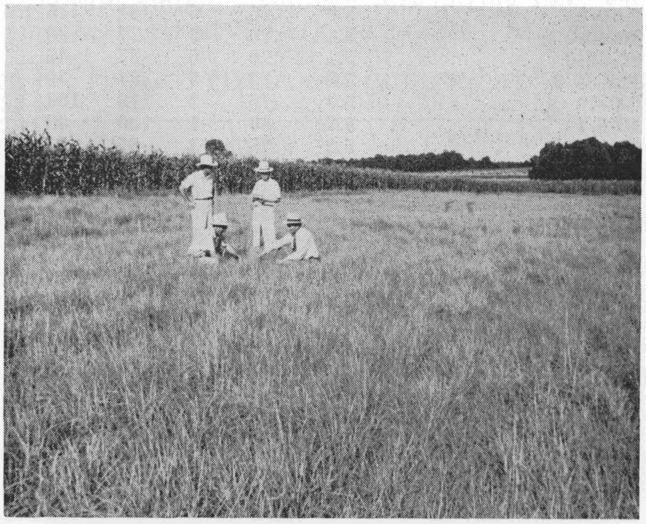


Figure 7. A little bluestem hay meadow on Substation No. 2 at Tyler.

A fertilizer experiment with little bluestem was conducted at Tyler during 1952-54, the last year being very dry. Yields also were taken from these plots in 1955 without any applied fertilizers to measure the residual effects of previous treatments. Results of this test are given in Tables 34 and 35. Comparable results may be expected with other grass species.

Little bluestem was established in a solid stand on cultivated land during the summer of 1945. The soil was sandy loam and had been cultivated for many years.

Table 34 shows that nitrogen increased yields more than either phosphorus or potash. Phosphorus increased yields somewhat, and potash not at all. However, Table 35, showing soil analyses, indicates that potash may become a limiting factor since the available potash in the soil decreased during the test. The yield data obtained show very good increases in yield from all increments of nitrogen, particularly from the 40 and 80-pound applications. The 120-pound application showed a further increase in hay yield, but not as much as the lower increments.

The 1955 yields show no residual effect of phosphorus nor of the 40-pound nitrogen application. The apparent increase from the 80-pound nitrogen application was not significant statistically; however, the 120-pound application did show a significant increase over the other treatments.

Yield increases from the use of fertilizers are necessary for economic reasons, yet a further advantage was obtained in the increased nutritive value of the hay, as shown in Table 34. The percentage of crude protein was increased from 5.39 where no nitrogen was used to 7.22 with 120 pounds of nitrogen. The use of nitrogen without phosphorus decreased the percentage of phosphorus in the hay, while phosphorus in all combinations increased its percentage in the hay. Phosphorus, as such, did not affect the protein content of the hay.

Chemical analyses of the soil were made before the test was started in 1951, and from each plot after completion of the test in 1955. Table 35 reveals that several changes occurred in the soil, which will influence future productivity and fertilizer requirements.

Soil acidity was increased at all sampling depths. The higher rates of fertilization resulted in lower pH readings (increased acidity). Periodic use of lime to correct the acidity is indicated. On the other hand, the calcium (lime) content at the end of the test was found to be higher than at the start. This apparently was due to sampling variability since the only calcium added was that contained in the superphosphate. Organic

TABLE 35. SUMMARY OF SOIL ANALYSES OF LITTLE BLUESTEM FERTILIZER TEST AREA PRECEDING AND FOLLOWING THE TEST, SANDY LOAM SOIL, TYLER

Treatment		pH	O. M. (%)	P_2O_5 (ppm)	K_2O (ppm)	CaO (ppm)	pH	O. M. (%)	P_2O_5 (ppm)	K_2O (ppm)	CaO (ppm)	pH	O. M. (%)	P_2O_5 (ppm)	K_2O (ppm)	CaO (ppm)
		0 to 3-inch depth					3 to 6-inch depth					6 to 12-inch depth				
Results before treatment[1]							6.0	.59	Tr.	76	Tr.	6.1	.39	Tr.	71	24
0-0-0		5.9	.81	3	84	96	6.1	.53	3	73	100	6.1	.61	2	72	243
40-0-0		5.3	.71	1	75	78	5.8	.40	2	47	104	5.8	.45	1	53	122
80-0-0		5.1	.71	2	65	32	5.3	.46	1	39	47	5.6	.40	2	45	98
120-0-0		5.0	.81	1	51	17	5.0	.49	1	34	33	5.4	.41	1	47	125
0-40-0		5.8	.76	6	81	115	5.9	.44	2	61	116	5.9	.46	1	50	120
40-40-0		5.4	.78	3	77	86	5.7	.40	1	50	82	5.7	.44	Tr.	58	182
80-40-0		5.1	.70	6	57	46	5.4	.37	2	41	92	5.7	.43	1	42	160
120-40-0		5.0	.72	5	54	30	5.1	.42	2	40	82	5.4	.39	1	50	270
0-0-40		5.9	.75	3	113	103	6.0	.42	2	91	76	6.1	.41	2	81	114
40-0-40		5.2	.80	1	100	45	5.6	.42	1	87	90	5.7	.44	1	79	180
80-0-40		5.2	.75	3	85	27	5.4	.44	2	68	64	6.0	.49	2	62	176
120-0-40		4.9	.69	2	71	3	5.2	.39	Tr.	53	21	5.4	.44	Tr.	73	147
0-40-40		5.8	.69	3	88	97	6.0	.42	2	77	84	5.9	.40	2	60	123
40-40-40		5.4	.84	5	104	83	5.7	.45	1	77	114	5.8	.48	1	62	142
80-40-40		5.3	.59	6	88	34	5.4	.41	3	61	82	6.0	.74	5	77	260
120-40-40		5.0	.70	7	84	12	5.0	.39	2	54	39	5.3	.48	1	68	171
						AVERAGES										
Nitrogen:	0	5.8	.75	4	91	103	6.0	.45	2	75	94	6.0	.47	2	66	150
	40	5.3	.78	2	89	73	5.7	.42	1	65	97	5.8	.45	1	63	156
	80	5.2	.69	4	73	35	5.4	.42	2	52	71	5.8	.61	2	56	270
	120	5.0	.73	4	65	15	5.1	.42	1	45	44	5.4	.43	1	59	178
Phosphorus:	0	5.3	.75	2	80	50	5.5	.44	1	61	67	5.8	.46	1	64	151
	40	5.3	.72	5	79	63	5.5	.41	2	58	86	5.7	.48	1	58	227
Potash:	0	5.3	.75	3	68	62	5.5	.44	2	48	82	5.7	.45	1	52	165
	40	5.3	.73	4	92	50	5.5	.42	2	71	71	5.8	.48	2	70	212

[1]Samples were divided into 0 to 6 and 6 to 12 inches. The analyses were made by the Department of Agronomy, College Sation, and those after treatment by the Soil Testing Laboratory, College Station.

matter was increased slightly, as might be expected under undisturbed sod crops. Phosphoric acid was increased at all levels, particularly in the upper sampling layer. Since all fertilizers were applied on the surface and phosphate ordinarily does not move about in the soil, it was to be expected that the accumulation, if any, would be near the surface. There was some accumulation of potassium on plots where this element was used, but a decrease occurred where it was not used.

It is evident that a fertilizer program that will maintain or increase soil productivity over many years must be based on soil analyses to keep all plant food elements in balance.

SILAGE CROPS

Cultural and Management Practices

Planting Dates

Dates for planting silage crops are subject to regional, seasonal and crop variations. Corn planting normally begins near the average date of the last frost, which results in most of the corn being planted during March. Sorghum planting dates vary from early April to mid-June, depending on location, cropping system and variety. Where the sorghum crop follows a winter crop in the system, planting usually is in late May or June. Possible conflicting labor demands for other farm operations at harvest time also influence the choice of planting dates. Where late planting is followed, a variety should be used that will mature before frost or before other hazards, such as winds or drouth, normally are expected. Varieties, such as Sumac and Hegari, may reach the silage stage in 70 to 75 days, while varieties, such as Honey and Sart, require 100 to 150 days. The planting date should be determined on the basis of the variety to be used and the most favorable growing season.

Planting Rates and Methods

Presumably each crop and variety has its optimum planting rate for each set of soil and climatic conditions. This has not been studied in most cases. Limited results indicated that excessive amounts of seed do not reduce sorghum yields. Results at Prairie View, Station Progress Report 1858, indicate that seeding rates materially influence forage quality, as shown in Table 36.

Under conditions at Prairie View in 1953-54 and with two different varieties, forage yields were not significantly influenced by seeding rate or method. Stalk diameter decreased with increased seeding rate. Stalk size also was less in broadcast stands than in rows, regardless of the planting rate. The percentage of the forage made up of leaves was essentially the same with both planting methods and all rates, but head production was 7 percent greater in row than in broadcast plantings. Increased planting rates reduced head production in broadcast plots. Figure 8 shows regular Hegari in 1954 in 40-inch rows and broadcast stands. The smaller stalk size in the broadcast plot is apparent.

Varieties having large stalks and requiring a longer growing season apparently require about the same seeding rate as Hegari and Sumac. Yields of Sart and Tracy (Table 37) were better with 8 pounds of seed per acre in 40-inch rows than with 4 pounds of seed. The test was on a fertile soil, but in a relatively dry season without irrigation. These data indicate that 6 to 8 pounds of seed per acre in rows are adequate for most sorghum varieties.

Corn Hybrids and Plant Spacing

No significant differences in the yield of corn silage were obtained when 12, 18 or 24-inch spacing were used in tests conducted at Tyler during 1952-54. Table 38 also shows there was no significant difference in the yield of any of the four hybrids included in the test, although Texas 30 and 34 showed slightly heavier average yields. Part of the value of corn silage is attributed to the grain content. Soil moisture during 1953 was very deficient at the critcial period. A compan-

TABLE 36. INFLUENCE OF SEEDING METHOD AND RATE ON FORAGE YIELD AND QUALITY AT PRAIRIE VIEW, 1953-54

Seeding method	Pounds of seed per acre	1953[1] Green weight, tons	1953[1] Dry weight, tons	1954[1] Green weight, tons	1954[1] Dry weight, tons	Stalk Diameter, mm	Stalk Height, inches	Percentage of total forage: Leaves	Stalks	Heads
Broadcast	40	14.7	2.9	10.7	3.1	7.6	57	25	46	29
	60	13.8	3.3	12.5	3.9	6.7	54	25	51	24
	80	14.7	3.4	12.0	3.8	6.4	56	31	49	20
	100	15.2	3.5	12.6	4.1	6.2	58	29	52	19
Average		14.6	3.3	11.9	3.7	6.7	56	27	50	23
40-inch row	7	14.4	3.9	12.0	4.0	12.9	71	36	42	22
	14	12.0	3.2	12.8	4.3	11.3	70	23	42	35
	21	13.0	2.8	13.9	4.6	11.3	72	22	46	32
	28	13.1	3.2	11.2	3.9	9.0	69	22	45	33
Average		13.1	3.3	12.5	4.2	11.1	70	26	44	30

[1]Sumac was used in 1953 and regular Hegari in 1954. Treatments did not influence yield significantly in either year.

Figure 8. Growth and stalk size of row, left, and broadcast, right, plantings of Hegari sorghum for silage.

ion study to the silage test showed grain yields of 0, 18.0 and 17.8 bushels per acre for the 12, 18 and 24-inch spacings, respectively. There was no significant difference between grain yields at the three spacings during 1952 and 1954. Spacings closer than 18 inches are of doubtful value unless sufficient moisture is assured.

Fertilization

The fertilizer requirements of silage crops have not been determined conclusively. It has been shown they will respond to applications of a complete fertilizer at planting plus a sidedressing of nitrogen. On upland sandy loam soil at Tyler, a 33-pound nitrogen sidedressing increased the per-acre yield of green silage 5.5 tons over that receiving only the basic application of 20-40-20. An additional 33 pounds of nitrogen further increased the yield by 2 tons. Soil analysis will serve as a guide to the proper fertilization at any particular location.

Mixtures Including Cowpeas

The use of cowpeas or soybeans might be expected to increase the yield and protein content

TABLE 37. FORAGE YIELD OF SART AND TRACY SORGHUM AS INFLUENCED BY SEEDING RATE, A&M PLANTATION, 1955

	Sart			Tracy		
Pounds of seed per acre	Green weight, tons per acre	Dry weight, tons per acre	% dry matter	Green weight, tons per acre	Dry weight, tons per acre	% dry matter
4	14.1	4.6	32.6	10.0	3.3	33.6
8	17.8	5.8	32.6	12.8	4.2	32.5
12	17.9	5.6	31.3	11.7	4.0	34.5
16	18.7	6.2	33.3	13.2	4.6	34.8

TABLE 39. FORAGE YIELDS OF CROPS GROWN FOR SILAGE WITH AND WITHOUT COWPEAS, TYLER, 1950

Variety	Tons of green matter per acre		
	Alone	With peas	Average
Hi-hegari	11.2	10.4	10.8
Starr millet	11.7	11.2	11.5
Atlas	11.3	9.9	10.6
Darso	5.1	4.5	4.8
Sweet Sudan	6.7	7.6	7.2
Pop corn	3.8	4.3	4.1
Sumac	9.9	7.5	8.7

TABLE 38. SILAGE YIELDS OF CORN VARIETIES AT DIFFERENT SPACINGS, TYLER

Variety	Tons of forage per acre (70 percent moisture)												
	12-inch spacing				18-inch spacing				24-inch spacing				Average
	1952	1953	1954	Average	1952	1953	1954	Average	1952	1953	1954	Average	
Texas 26	8.2	3.7	6.2	6.0	8.8	3.1	5.3	5.7	9.1	3.6	4.5	5.7	5.8
Texas 28	9.5	4.8	5.9	6.7	7.7	3.5	6.7	6.0	7.9	3.8	5.3	5.7	6.1
Texas 30	7.8	4.4	6.3	6.2	9.7	3.6	8.0	7.1	8.2	3.6	7.0	6.3	6.5
Texas 34	10.4	3.7	6.2	6.8	9.3	2.9	6.7	6.3	8.8	3.7	5.4	6.0	6.4
Average	9.0	4.2	6.2	6.4	8.9	3.3	6.7	6.3	8.5	3.7	5.6	5.9	

Figure 9. Honey (left) and Sart (right) varieties of sweet sorghum being grown for silage.

of the silage. A test at Tyler in 1950 failed to show any advantage of planting Chinese Red cowpeas with a number of crops grown for silage. Table 39 indicates yields tended to be decreased in five of seven combinations. The planting and possibly the harvesting of the mixture is more troublesome than when only one kind of seed is used; thus, there is little or no advantage in using cowpeas with the crops used in this test.

Crop Varieties and Yields

A very important consideration in silage production is yield per acre. The yield is determined by a number of factors, among which are available plant food, moisture, cultural practices and variety. Yields may be too low for economic returns, or may be too high for satisfactory harvest with the available machinery. Excessively tall

TABLE 40. SILAGE YIELDS, TONS PER ACRE AT 70 PERCENT MOISTURE

Variety	Kirbyville			Orange	Nacogdoches							Mt. Pleasant				Tyler	
	1953	1954	1955	1955	1949	1950	1951	1953	1954	1955 Cutting 1st	1955 Cutting 2nd	1950	1951	1952	1953	1953	1954
Sweet sorgos																	
Atlas	8.8		20.3	13.0	8.8	11.3	10.2	19.0	8.8	7.1	12.5	12.2	14.2	11.3	11.6	6.8	3.7
Honey	13.1	28.0	20.7	14.1				27.0	4.5			21.5	12.2	15.3	32.6	10.8	3.7
Honey Drip	20.0	33.6	19.9	14.5	14.2	19.3	10.5			11.3	9.1					7.4	
Sumac (Red Top)	16.9	12.0	15.5	9.8	4.2	15.0	10.5	12.3	8.5			12.2	10.8	9.3			4.1
Orange					7.6	12.5	8.5					11.0	12.5	7.9			3.3
Jo-Hee												12.5	14.2	10.8	13.0	6.9	4.2
Gooseneck	11.6	8.4			7.4	11.6	3.7					7.6	10.8				
Black Amber		8.0			4.8	8.2	1.7					5.7	13.0	5.9			
Straight Neck					8.5	13.6	9.1					14.2	14.2				
Hodo			29.0	14.9						8.8	6.5						
Leoti			14.9	8.8													
Tracy			27.4	15.6						11.1	6.5						
Sart			25.8	15.1						13.3	3.7						
Ellis														7.1			
Norkan														7.1			
Grain sorghums																	
Hegari	20.8	11.5			8.8	12.2	3.7					11.0	11.0	9.1			
Early hegari	17.0	11.9	15.0	6.1	4.2	10.2	2.5							7.4			
Hi-hegari			11.4	8.5				19.1	3.7				15.0	8.5	20.1	7.9	3.7
Texas Milo	14.1											13.3	10.8	8.8			
Blackhul Kafir	6.8					11.9	5.9										
Sagrain (Schrock)					5.9	8.8	6.2					11.9	10.2				
Darso					5.1	11.9	9.1					9.3	10.5	8.2			
Bonita					3.7	8.2	5.7					5.9	9.6	7.1			
Corn																	
Texas 26																5.0	
Texas 28			18.2	11.6		8.5	5.1		6.5			9.9	7.9	7.1			
Texas 30								7.7							9.4	6.2	2.7
Texas 34			24.5	13.9				5.9	7.7						11.9	6.4	3.3
Other																	
Common Sudan	6.6	12.1															
Sweet Sudan	4.5	10.7			3.7	6.2	2.5					4.2	6.2	5.1			
Pearl millet	13.3	16.7															
Starr millet						9.6	2.8					2.0					

TABLE 41. SILAGE YIELDS IN SMITH AND UPSHUR COUNTIES

Variety	Tons of green weight per acre							
	1951	1952	1952	1952	1952	1953	1953	1953
	Smith	Smith	Smith	Upshur	Upshur	Smith	Upshur	Upshur
	Upland	Upland	Upland	Bottom land	Upland	Upland	Bottom land	Bottom land
Sugar Drip	18.5							
Honey Drip	17.9		13.4	21.1	10.9	27.0	17.3	20.7
Jo-Hee	14.8	10.7	11.5	17.4	12.1	21.5	14.8	25.3
Sumac (Red Top)	9.6	9.3	11.0			13.9		
Darso	8.8							
Sweet Sudan	7.6					5.7		
Atlas		13.0	10.6		10.6	16.1	13.9	17.2
Orange		12.1						
Hegari			9.0	11.4	8.2	14.1	12.0	18.3
Golden Rod				20.5			16.0	26.2

and heavy sorgos are difficult to harvest with field choppers and impractical with row binders and stationary cutters. The most desirable crop is the one which will produce the maximum yield that can be handled economically with the available facilities. For instance, a crop of Honey or Honey Drip that is 12 or more feet tall and yielding in excess of 25 tons per acre would be impractical to handle without a field chopper and adequate power.

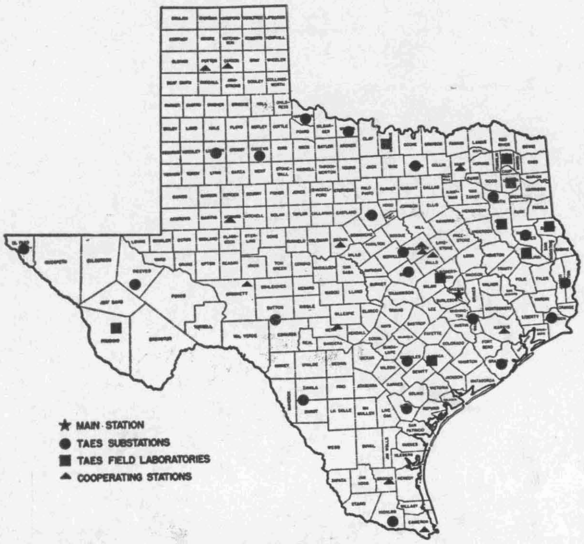
As mentioned previously, the choice of a late or early-maturing variety may fit better the other farming operations. No one variety will fit all conditions. Yields of several sweet and grain sorghums, corn and other crops are reported in Tables 40 and 41. In general, the best yields were obtained from the sweet sorghums. Honey, Atlas and Honey Drip, with its synonyms, usually were among the top yielding varieties. Hi-hegari, under favorable conditions, yields well, but lodges frequently. The newer varieties, Tracy and Sart, are promising where late-maturing varieties can be used. Local varieties have proved to be well adapted and satisfactory in some areas, as is Jo-Hee around Mt. Pleasant.

Corn usually is less productive than some of the sorghums, but at times it makes good yields of high quality silage. Its earliness, 80 to 95 days, often permits a fair crop before damaging summer drouths. Under adverse moisture conditions, the yields of grain and silage will be low. However, a corn crop planted for grain can be salvaged as silage if an unfavorable season limits grain production.

Sudangrass usually is considered a grazing or hay crop, but good silage also may be made from it. Because of its ability to produce successive crops as long as conditions are favorable, it is possible to use one crop for silage and the remainder for grazing. This double use is particularly applicable where conditions are such that the first Sudan crop is not needed for pasture, but the second may be. Because of its lower yields, Sudangrass is not recommended solely for silage.

Pearl millett is adapted to uses similar to Sudan. It should fit into use situations as described for Sudan, especially in Southeast Texas.

[Blank Page in Original Bulletin]



Location of field research units of the Texas Agricultural Experiment Station and cooperating agencies

State-wide Research

★

The Texas Agricultural Experiment Station is the public agricultural research agency of the State of Texas, and is one of ten parts of the Texas A&M College System

ORGANIZATION

IN THE MAIN STATION, with headquarters at College Station, are 16 subject-matter departments, 2 service departments, 3 regulatory services and the administrative staff. Located out in the major agricultural areas of Texas are 21 substations and 9 field laboratories. In addition, there are 14 cooperating stations owned by other agencies. Cooperating agencies include the Texas Forest Service, Game and Fish Commission of Texas, Texas Prison System, U. S. Department of Agriculture, University of Texas, Texas Technological College, Texas College of Arts and Industries and the King Ranch. Some experiments are conducted on farms and ranches and in rural homes.

OPERATION

THE TEXAS STATION is conducting about 400 active research projects, grouped in 25 programs, which include all phases of agriculture in Texas. Among these are:

- Conservation and improvement of soil
- Conservation and use of water
- Grasses and legumes
- Grain crops
- Cotton and other fiber crops
- Vegetable crops
- Citrus and other subtropical fruits
- Fruits and nuts
- Oil seed crops
- Ornamental plants
- Brush and weeds
- Insects
- Beef cattle
- Dairy cattle
- Sheep and goats
- Swine
- Chickens and turkeys
- Animal diseases and parasites
- Fish and game
- Farm and ranch engineering
- Farm and ranch business
- Marketing agricultural products
- Rural home economics
- Rural agricultural economics
- Plant diseases

Two additional programs are maintenance and upkeep, and central services.

Research results are carried to Texas farmers, ranchmen and homemakers by county agents and specialists of the Texas Agricultural Extension Service

AGRICULTURAL RESEARCH seeks the WHATS, the WHYS, the WHENS, the WHERES and the HOWS of hundreds of problems which confront operators of farms and ranches, and the many industries depending on or serving agriculture. Workers of the Main Station and the field units of the Texas Agricultural Experiment Station seek diligently to find solutions to these problems.

Today's Research Is Tomorrow's Progress