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Chapter 6

IMPROVED GRASSES AND LEGUMES

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Chapter 6

IMPROVED GRASSES AND LEGUMES

E. C. Holt *

Introduction

Plant breeding attempts to enhance favorable characteristics and to correct deficiencies or limitations in plants. Plant breeding programs are designed to develop superior varieties, but generally this means improvement in only one or a few characteristics. In forage crops these generally involve one or more of the following: increased forage production; improvement in seed production characteristics such as yields, seed size, quality; improved forage quality; winter or cold hardiness; growth habit (erect, decumbent, etc.); drouth tolerance; disease resistance; persistence; and others.

Improvement, especially of perennial crops, is slow and time consuming, often requiring years of selection, evaluation, reselection, and further evaluation before a variety is finally ready for release. Because of the wide range of grasses and legumes with some degree of adaptation to Texas conditions, only a few have been improved through breeding. Most of the grasses and legumes planted for forage production were introduced from other parts of the world. Many of these are being used successfully in the form in which they were introduced.

While improvement efforts have been made on numerous grasses and legumes, variety development has not been possible for all of the conditions and needs. This has necessitated using many varieties from other states and areas. Even after a variety is developed, extensive testing and evaluation are necessary to determine areas of adaptation and suitable production and management practices.

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The grass and legume varieties available for use in Texas have come from various programs, both public and private, including The Texas Agricultural Experiment Station, other State Experiment Station programs, cooperative programs with the Agricultural Research Service and the Soil Conservation Service, commerical companies and private individuals. No effort is made in this chapter to describe all the available varieties nor does the absence of a variety imply that it is of no value. Rather, the descriptions are limited to some of the major developments to which scientists of the Texas Station have made or are making significant contributions either in the development or in the testing and expanded use of the variety.

KLEINGRASS 75

B. E. Conrad *

Kleingrass (Panicum coloratum L.) is a warm-season perennial bunchgrass introduced into this country from Africa. Introductions were made as early as 1942, but it was not until the 1950's that desirable types were introduced and evaluated. Kleingrass 75, a variety developed in Texas jointly by the Soil Conservation Service and the Texas Agricultrual Experiment Station, was approved for certified seed production in 1968.

Kleingrass 75 is fine-stemmed, leafy and grows to a height of 3 to 4 feet at maturity (Figure 6-1). The variety is variable morphologically: some plants display abundant pubescence, while others are relatively smooth; individual plants vary in color from a pale green to a dark bluish-green; growth form varies from semi-prostrate to erect, but most plants are upright. Kleingrass spreads by tillers or short rhizomes, and stems will root at the nodes when they come in contact with wet soil.

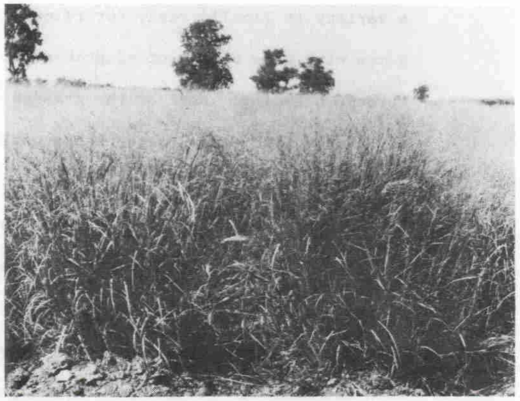

Figure 6-1. Kleingrass 75.

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The nutritive value of Kleingrass 75 ranks high among warm-season perennial grasses. The grass is palatable to livestock and has exhibited above average protein content ranging from 17 percent in early spring to about 7 percent during the summer (Holt, 1966). The digestibility of Kleingrass is also above average for warm-season perennials, ranging from 65 to 70 percent in the spring and from 55 to 65 percent in summer and fall depending on age of the plants.

Adaptation

Kleingrass 75 is adapted to a wide range of soil and climatic conditions. Successful plantings have been made on the heavy soils of Central Texas under dry conditions and on wet soils in the Gulf Coast. The grass also has been grown successfully on shallow, sandy soil near College Station, and on deep sand and medium-textured soils in the Rio Grande Plains and Rolling Plains.

Kleingrass 75 has shown a wide variation in its adaptation to moisture regimes. The grass has shown good drouth tolerance; however, dry-matter production is dependent on both the amount and distribution of moisture. The lower limits of moisture for survival and growth have not been specifically determined, but it has been grown successfully in areas where the average annual precipitation is less than 20 inches. The grass has also shown good cold tolerance; however, stand losses have occurred in the Panhandle area during severe winters the year of establishment. Established stands which survive the first winter appear to be able to tolerate the expected low temperature in most of the state.

Kleingrass 75 has been grown predominantly for grazing and seed production in Texas. No feeding studies comparing Kleingrass 75 hay with other hay sources have been conducted, but limited observations indicate the species to be well suited for hay production.

Seed Production

Kleingrass 75 is a prolific seed producer; however, due to seed shattering and indeterminate flowering, many seed are lost prior to and during harvest. Flowering in Kleingrass 75 begins at the top of the inflorescences and progresses downward; thus, shattering may be observed at the tip while the florets near the base are in anthesis (blooming). In a study conducted near College Station (Holt, 1965) peak spring seed yields were harvested approximately 10 days following the first apparent seed shattering, whereas in the fall, peak seed yield occurred 5 days after initial shattering. Although seed yield may vary from year to year depending on cultural practices, methods of harvest and climatic conditions, the time intervals for maximum harvestable seed in the spring and fall are of a short duration. Depending on the frequency and method of harvest and preharvest cultural practices, yields of 100 to 150 pounds of pure seed per acre may be expected. Because of dormancy, Kleingrass 75 seed are low in viability immediately after harvest. Viability increases with time, and good seed germination is obtained after approximately 6 months. Thus, freshly harvested seed are not satisfactory for planting.

Establishment

Kleingrass 75 is easily established from seed. The seedling plants are sturdy, have good root development, but initially grow slowly. Because of the small seed size, a clean, firm, well-prepared seedbed is essential. Although a number of planting devices have been employed, a mechanism capable of handling small seed is necessary. Vegetable planters and grass drills with depth bands for planting 1/2 to 3/4 inch deep have been commonly used. Good stands have been obtained at seeding rates of 3/4 to 1 pound of pure live seed (PLS) per acre in 36- to 42-inch rows, or 2 pounds PLS broadcast or close drilled. Due to the slowness of initial growth, weed control in new plantings is highly important. In areas where weedy grass is likely to be present, row plantings are recommended so competition can be reduced by cultivation. Kleingrass 75, generally, is seeded in early spring after danger of frost is past. However, in South Texas early fall plantings have been successful. In areas where the winters are mild and of short duration, fall plantings have enabled the plants to become extablished during a period when weed growth is minimal, thus reducing competition during the period of slow growth. Once through the seedling stage the plants are better able to

compete with annual weeds the following spring.

Performance

Dry Matter Production

Kleingrass 75 starts growth early in the spring and remains green late in the fall. Forage production is dependent on the amount and distribution of moisture. Kleingrass 75 does not have the yield potential of grasses such as Coastal or Pretoria-90 bluestem, but it is comparable to dallisgrass and Medio bluestem (Table 6-1). Dry

Table 6-1. Forage yield of warm-season grasses, Texas A&M University Farm near College Station, Texas.

Variety	1957	1958	1959	1960[1]
Kleingrass	9,130	4,650	9,770	3,160
Medio bluestem	5,270	4,330	9,830	3,430
Pretoria-90 bluestem	13,350	10,020	17,530	4,990

[1]Only one cutting in 1960 becuase of poor survival of other species in the test.

matter production at Beeville under several fertilization rates is shown in Table 6-2.

Table 6-2. Dry-matter production of Kleingrass 75 at Beeville by years

		Pounds dry forage per acre		
Fertilizer rate[1]	1964	1965	1966	Average
0-0-0	3,410	2,660	1,830	2,630
20-0-0	4,220	3,840	2,680	3,580
20-20-0	4,450	5,030	3,350	4,280
40-20-0	4,920	6,200	4,560	5,230
60-20-0	4,990	6,710	5,280	5,660
Annual precipitation inches	22.08	34.92	26.15	

[1]Pounds nitrogen, phosphoric acid and potash per acre, respectively.

Animal Performance

Grazing trials at the Texas Agricultural Experiment Stations at Beeville and

McGregor (Table 6-3) indicate higher individual animal gains and gain per acre with

Table 6-3. Summary of steer grazing results for Kleingrass 75 and Coastal bermudagrass at McGregor and Beeville, 1964-69. Weighted averages.

	Beeville		McGregor	
	Kleingrass	Coastal	Kleingrass	Coastal
Years tested	4	4	2	5
Stocking rate, acres per animal	1.0	1.0	1.08	1.63
Animal grazing days, per acre	154	142	113.0	109.5
Gains, pounds per acre	228	121	175.5	130.7
Average daily gain, pounds per animal	1.48	o.85	1.55	1.19

Kleingrass than with Coastal. At both Beeville and McGregor moisture becomes a limiting factor in forage production, particularly during the summer; thus, the growth potential of grasses such as Coastal is seldom realized. In East Texas and the upper Gulf Coast of Texas or under irrigation, Coastal might be expected to have a higher carrying capacity than Kleingrass 75.

In South Texas fall growth of Kleingrass 75, allowed to accumulate, has been utilized as a winter pasture after frost. This practice has been successful due to the mild winters and the ability of Kleingrass to break dormancy and start growing during short periods of warm temperature.

Prospects for the Future

Kleingrass 75 appears to be well adapted to most areas of the State. The grass has shown good persistence, drouth tolerance, and is readily accepted by livestock. To date, there have been no major insect or disease problems associated with Kleingrass 75. Kleingrass 75 has not been evaluated under a wide variety of production systems. How the grass will compare with other species under high fertilization in the high rainfall areas or under irrigation is not known.

The development of types with better seed production is in progress, and this should lead to greater and more consistent seed availability.

TAM WINTERGREEN HARDINGGRASS

M. J. Norris *

TAM Wintergreen hardinggrass, (Phalaris acquatica L.) [Syn. P. tuberosa var. stenoptera (Hack) Hitchcock], is a new perennial cool-season grass with good summer drouth resistance (Figure 6-2). The most widely used species name for this grass is

Figure 6-2. TAM Wintergreen hardinggrass.

P. tuberosa, but P. acquatica has been used by recent writers (Anderson, 1961).

Description

TAM Wintergreen was developed at the Texas A&M University Agricultural Research Center at McGregor. It resulted from an increase of bulked seed from three plants from P. I. 193056 and P. I. 196338 that survived severe summer drouths during 1953 and 1954. Foundation seed was first released in 1968.

Physical appearance and characteristics of TAM Wintergreen are similar to other cultivars of the same species. It is a perennial bunchgrass with short rhizomes.

*Associate professor, The Texas Agricultural Experiment Station, Temple.

Original plants spread slowly from rhizomes but not enough to develop a full cover from a partial field stand.

Forage growth is leafy with few stems produced until late spring. Leaves are 1/4 to 3/8 inch wide and the mature plant is 3 1/2 to 5 feet tall. The head is a compressed panicle of 3/4 to 2 inches in length.

Summer dormancy starts with a depression of tillering which seems to be associated with plant heading and environmental factors of high temperature and dry weather (Laude, et al., 1968, and Hoen, 1968). The reduction in tillering influenced by heading is temporary as tillering starts again in late summer with rain and cooler temperatures. Grazing or clipping plants as heading is initiated increases tillering.

Digestion trials indicate that TAM Wintergreen forage is comparable in quality to oat forage. Average daily gains of steers have been slightly lower on TAM Wintergreen than on oats (Table 6-4). Palatability and nutritive value of TAM Wintergreen

Table 6-4. Summary of grazing results with beef steers on TAM Wintergreen hardinggrass and Alamo-x oats at McGregor, Texas during 1968-71.

	1968	1969	1970	1971	4-year average
TAM Wintergreen pastures					
Stocking rate, acres per animal	2.3	1.5	1.6	1.4	1.7
Animal grazing days per acre	82	138	113	111	111
Livestock gains, pounds per acre	151	194	240	115	175
Ave. daily gains per animal, lbs.	1.8	1.4	2.1	1.0	1.6
Alamo-x oat pastures					
Stocking rate, acres per animal	1.7	1.4	1.6	1.5	1.5
Animal grazing days per acre	110	129	102	93	108
Livestock gains, pounds per acre	208	257	224	136	206
Ave. daily gains per animal, lbs.	1.9	1.9	2.2	1.5	1.9

forage has been satisfactory for cattle and sheep.

The main advantage of TAM Wintergreen over other cultivars of this species is increased persistence due to better winter hardiness and summer drouth resistance.

Adaptation

This grass is well adapted to the 20- to 40-inch rainfall area of Texas south of Red River and also can be used in other areas under certain conditions. It has

performed well in heavier rainfall areas of East Texas on soils with good internal drainage but is short lived on soils with a high water table. The species will grow in areas with less than 20 inches total rainfall if at least 12 inches of rain is obtained during the growing season (McMasters and Cook, 1967).

TAM Wintergreen seedling plants are relatively tender but have about the same range of cold hardiness as seedling alfalfa or Madrid sweet clover. One stand of seedling grass winterkilled at 25° F, but a number of plantings have survived temperature ranges of 5° to 20° F. Seedling grass that emerged by November 15 has survived the first winter at McGregor, Texas. Plantings that emerged later than that date had severe winterkilling at minimum temperatures of 12° to 16° F. Winterkilling has not been a serious problem for plantings over one year old, but the top growth is frozen at 10° and 15° F. Spring-planted, irrigated fields for seed production have survived several winters at Plainview, Texas (Don Robinson, personal communication), with good stands.

Performance

Forage yield and first-year survival of TAM Wintergreen have been higher than other *Phalaris* cultivars under Texas conditions (Table 6-5).

Table 6-5. Forage yields and survival of TAM Wintergreen hardinggrass and other perennial wintergrowing grasses at several locations during 1958-66.

Strain species	Air-dry forage, pounds: First year: Number of Tests	First year: Comparable Yield	Second year: Number of Tests	Second year: Comparable Yield	First year Survival: Number of Tests	First year Survival: Percent
TAM Wintergreen hardinggrass	8	2,473	3	5,295	7	73
Commercial hardinggrass[1]	7	2,155	1	2,195	6	48
Angleton strain P, tuberosa[1]	1	2,066	1	4,633	1	7
Phalaris bulbosum	2	2,290	1	4,887	2	73
F. C. 37738 P. tuberosa			1	5,131	1	67
F. C. 37760 P. tuberosa			1	4,638	1	39
F. C. 37727 P. tuberosa			1	5,316	1	22
F. C. 34226 P. tuberosa	2	2,433	1	4,728	2	73
F. C. 33587 P. coerulescens[2]	1	2,256	1	0	1	0
Koleagrass[3]	7	2,165	1	3,224	4	48
Alabama reed canary	7	1,547	1	5,110	5	41

[1] Severe winter killing at McGregor during first year grown.
[2] Survived first winter but died during summer drouth.
[3] Koleagrass winter killed severely at Denton and McGregor but performed as well as TAM Wintergreen hardinggrass at locations further south.

Koleagrass, Phalaris tuberosa var. hirtiglumis, is as good a forage producer as TAM Wintergreen from College Station south but is not winter-hardy at Denton and McGregor. Strain F. C. 33587 Phalaris coerulescens shows winterhardiness equal to Wintergreen but has low summer survival. TAM Wintergreen also produces more forage and has better drouth resistance than Kentucky 31 tall fescue, but the Kentucky 31 has better winter survival in the seedling year. Unselected Phalaris acquatica has produced twice as much forage as Kentucky 31 fescue in forage tests in Alabama (Hoveland and Anthony, 1971).

Steer gains per acre and average daily gains per animal are lower on TAM Wintergreen than on oats at McGregor (Table 6-4), but the results are so close that the perennial nature of TAM Wintergreen should equalize the more favorable grazing advantage of oats. During periods of drouth, TAM Wintergreen furnished more grazing than oats (Norris et al., 1968). Animal performance from pastures in Limestone and Robertson counties (Table 6-6) indicate annual gains of 255 to 355 pounds per acre.

Table 6-6. Grazing results on TAM Wintergreen pastures near Kosse, Texas during the 1970-71 winter grazing season*.

Field No.	Acres	Steers	Grazed	Average daily gain	Gain per head	Total gain per acre
36	49	73	142	1.21	171	255
32	90	135	155	1.44	223	335
31	64	199	81	1.28	104	322

*These data were furnished by Mr. Tom Bowers and the Richland Development Corporation.

Where adequate stands have been obtained, the forage yield and animal performance have been comparable with those obtained from small grains.

Management

The optimum fall planting date is September 1 to October 15, similar to alfalfa and sweetclover. September is not an ideal planting time in Central Texas because of periods of high temperature (over 90° F) and drouth unfavorable for growth of the seedling grass. However, early fall planting is necessary to enable young seedlings to make enough root growth to survive the winter. Early spring planting, from February 1 to March 1, is also recommended. Spring planting minimizes the danger of winter-

killing but increases competition from warm-season weeds.

The seedbed should be prepared well in advance of the planting date and should be clean, firm, and smooth. Seed should be covered 1/4 to 3/4 inch on a firm seedbed. It is better to plant seed shallow than risk planting them too deep. More stand failures result from planting seed too deep than from any other cause!

Plantings may be in rows spaced 20 to 40 inches apart or close drilled. The recommended planting rate is 1 to 1 1/2 pounds of pure live seed (PLS) per acre in rows spaced 30 to 40 inches apart, 2 pounds PLS per acre in rows spaced 20 inches apart, and 3 pounds PLS per acre in rows spaced closer than 20 inches.

Young seedlings are not as vigorous growing as those of small grains and cool-season annual grasses. Thus, grazing should be delayed until the forage is about 12 inches tall. Seedlings from fall plantings usually reach this height about March 1. This means the fall-planted grass cannot be grazed until March, and spring-planted grass should not be grazed until fall.

Heavy grazing or close clipping in the late spring reduces summer survival during drouth years. Pastures stocked during April 15 to May 15, so that a general forage height of 6 inches is maintained with the grazing animals removed by May 15, have had good summer drouth survival.

In Alabama June and July clipping reduced fall and winter forage production of hardinggrass 55 percent compared with unclipped plots (Berry and Hoveland, 1969). California workers found that frequent clipping of forage during the most active period of growth reduced yields, reduced carbohydrate reserves in the stem base, and increased plant death rate (McKee, Whalley, and Brown, 1966).

The general recommended grazing management practices for TAM Wintergreen hardinggrass follow: allow new growth of grass to get about ten inches high before fall grazing is started (about October 1); undergraze pastures through December to accumulate forage for the coldest part of winter; after February 15, stock to maintain a general forage height of about 6 inches; remove grazing animals by May 15 to allow plants to recover and store reserves for good summer survival.

TAM Wintergreen responds readily to fertilizers and has fertility requirements similar to small grains the first two years after planting. Stands of grass over two years old generally require 20 to 30 pounds more nitrogen per acre than oats for the same level of forage production as oats.

Problems and Needs

The most serious problem with TAM Wintergreen hardinggrass has been the difficulty of establishing stands. This difficulty has generally been due to poor emergence and winterkilling of the newly emerged seedlings. The problem can be minimized, but not entirely eliminated, by following recommendations on seedbed preparation and planting. A strain of this species is needed with more cold tolerance and seedling vigor.

No serious problems have so far occurred from livestock grazing TAM Wintergreen, but there is a possibility of toxic levels of indolealkylamine developing in the forage. This alkaloid has occurred in toxic levels in Australia and causes a condition in sheep and goats known as Phalaris staggers (Australian Commonwealth Science and Industry Quarterly, 1967). Research workers in the United States have found a wide variation of the content of this and related alkaloids in the P. acquatica species (Rendig, Welch and McComb, 1970). Low levels of this toxic compound have been found in TAM Wintergreen forage (B. J. Camp, personal communication).

Future Prospects

There are real opportunities for improvements in seedling vigor and cold survival as well as improvement of other qualities by selection from within the P. acquatica species as well as selection from hybridization with other species of Phalaris. A nursery of bulk hybrid plants of P. acquatica x P. arundinacea has been established at the Texas Agricultural Experiment Station at McGregor for the purpose of combining the seedling vigor and winterhardiness of P. arundinacea with forage qualities and drouth resistance of P. acquatica.

GULF RYEGRASS

J. P. Craigmiles *

Description

Italian Ryegrass (Lolium multiflorium Lam.), a native of the Mediterranean region, was brought to America in early colonial days (Schoth and Weihing, 1962) and has since become an important grass, especially in the Pacific Northwest and in the southern humid states.

Gulf annual ryegrass (Figure 6-3) is a direct increase of La Estanzuela 284,

Figure 6-3. A typical plant of Gulf ryegrass in the flowering stage.

*Professor and resident director, The Texas Agricultural Experiment Station, Beaumont.

an improved variety from Uruguay. The seeds were introduced in 1950, by the Crops Research Division, ARS, U. S. Department of Agriculture as P. I. 193145. It was first tested in 1952, by The Texas Agricultural Experiment Station, and, because of its consistent superiority in total forage yield, resistance to crown rust (Puccinia coronata Cda.), and good adaptability for use in Texas, was named and cooperatively released in 1958 by the Crops Research Division, ARS, and The Texas Agricultural Experiment Station (Weihing, 1963b).

Gulf ryegrass, with its resistance to leaf rust, is an exceptionally high quality forage. It contains over 20 percent protein in early stages of growth but becomes stemmy and drops to 5 to 7 percent protein at maturity. The addition of clover improves both the production and the nutritive value of Gulf ryegrass (Schoth and Weihing, 1962). Riewe (1966), in studies conducted at Angleton, made equal amounts of forage available for grazing, and found that steers on ryegrass-clover pasture gained significantly more than steers on nitrogen fertilized forage.

Adaptation

Gulf ryegrass can be grown in the same region where common ryegrass grows. It is not a dryland grass and does not thrive in climatic extremes of cold, heat, or drouth. Gulf has good rust resistances; consequently, it flourishes in the humid coastal region. It is also adapted to East and Central Texas where moisture is adequate.

Gulf ryegrass has a wide range of soil adaptation. It does well on bottomland, upland, or on prairie soils, as long as soil fertility is medium to high. High moisture levels stimulate ryegrass production. Although ryegrass can withstand "wet feet," production usually declines as the drainage gets poorer. It cannot endure flooding.

The main use of Gulf ryegrass in Texas is for forage, and its primary forage use is for winter grazing. It is a versatile grass, and, because of easy establishment and quick response to nitrogen, it has become a grass of many uses. Some of these are pasture, silage, hay, temporary winter lawns, winter putting greens, erosion prevention, green manure, and mixtures with legumes to reduce bloating in grazing animals.

Performance

Dry Matter Yields

Gulf ryegrass is the most productive cool-season annual tested at Beaumont with yields at 2 3/4 tons per acre, (Craigmiles and Weihing, 1971). The protein content exceeds 20 percent on forage harvested by February but drops to 8 to 10 percent by mid-May (Gulf ryegrass, 1958). Gulf ryegrass requires liberal nitrogen fertilization for high production and is highly responsive to fertilization. Gulf has produced over 2,000 pounds of dry matter in four cuttings from December 1 to March 1, when 30 pounds of N per acre were applied at seeding and after each cutting (Weihing and Evatt, 1960b). Plots not fertilized with nitrogen produced only 1,160 pounds. More recently, forage yields at Overton for a wheat-ryegrass experiment were linearly related to rate of nitrogen(Matocha, McCartor, and Ott, 1971). Protein production also is a function of nitrogen fertilization (Westfall, Smith, and Evers, 1971).

Dry matter production is influenced also by light, temperature, and frequency of grazing or top removal (Weihing, 1963a). However, Gulf has shown less sensitivity to reduced light and to frequent, close defoliation than cereal varieties which are grown during the same season (Holt, Norris, and Lancaster, 1969). Gulf decreases in growth rate as average temperature decreases, and growth essentially stops at 40 to 45° F (Weihing, 1963a). A similar pattern has been reported for cereal varieties (Holt, Norris, and Lancaster, 1969).

Animal Production and Performance

Animal production and performance are influenced by level of forage production and grazing intensity. Performance may be relatively poor for a few days after animals are first put on Gulf, but average daily gains of 1.5 to 2.0 pounds for the grazing season are obtained (Riewe, 1966). Animal production in excess of 350 pounds of gain per acre has been reported from Angleton (Riewe, 1966). At Overton, gains of 364 pounds from November 4 to May 21 from calves grazing wheat-Gulf ryegrass pasture have been recorded (McCartor and Taylor, 1970). The production cost per pound of gain was 13.9 cents whereas calves on Coastal bermudagrass hay plus supplement gained 228 pounds in the same period at a cost per pound of 25.5 cents.

Seed Production

Harvesting ryegrass seed usually begins in mid-May for ryegrass seeded the middle of October. If cut and windrowed, harvest should start when a few mature seeds shatter as the head is pulled through the hand. Yields up to 500 pounds of clean seed per acre have been obtained in Texas (Weihing and Evatt, 1960a). Combine harvesting without windrowing may be started when seed are somewhat more mature. The moisture content of these seed is usually higher, and artificial drying is necessary. Yields obtained by combining are generally about 100 pounds per acre higher than by other methods. Hand harvested seed from ungrazed small plots at Beaumont where March applications of 0, 30 and 60 pounds N per acre had been applied yielded 800, 910 and 1,091 pounds per acre, respectively. Where the grass had been clipped three times prior to harvest to simulate grazing, the seed yields were 510, 860 and 1,100 pounds, respectively (Weihing and Evatt, 1960a). One to one and one-half tons of dry forage per acre containing 400 to 600 pounds of protein were removed prior to March 1.

Management

Establishment

Ryegrass should be planted one-half inch deep on a firm, well-tilled seedbed prepared the same as for cultivated crops. Ryegrass following rice can be successfully established by aerial seeding in the stubble after harvest or in the standing rice approximately two weeks prior to combining.

Seeding rates of 5 to 10 pounds of clean seed to the acre give satisfactory results (Riewe, 1965). More early grazing has been obtained with heavier seeding rates. On poorly prepared seedbeds and under drouthy planting conditions, seed rate should be increased to 20 pounds.

Maximum forage is obtained in the Coastal Prairie (Craigmiles and Weihing, 1971) by seeding between September 15 and October 15. Seeding later results in late, unprofitable grazing. Early seeding is critical for early grazing.

There is no substitute for a well-prepared seedbed. However, a wheat-ryegrass mixture overseeded in Coastal bermudagrass with no seedbed preparation furnished good

pasturage for approximately five months from December through April at Overton (Matocha, 1972). At Angleton early winter grazing is obtained from sod seeding only if chemicals are applied to induce sod dormancy, high nitrogen rates are applied at planting, and early planting is practiced. Mixing wheat or other small grain with ryegrass provides earlier grazing (Riewe, 1965).

Ryegrass requires large amounts of nitrogen, phosphorus, and potash. Where clover is grown with ryegrass, the nitrogen requirement can be reduced. Ryegrass yields have been increased approximately 150 percent by the addition of 100 pounds of nitrogen. Protein content increases directly with increased nitrogen up to 200 pounds (Weihing and Evatt, 1960b).

BUFFELGRASS

E. C. Bashaw *

Buffelgrass (*Cenchrus ciliaris* L.) is a perennial bunchgrass native to Africa and India. Tests of plant introductions in the early 1950's showed the species to be highly drouth resistant and well adapted to South Texas. Breeding studies since that time have resulted in the development of basic breeding materials, a unique breeding system, an improved cultivar (Higgins), and numerous promising hybrids.

Sexual Buffelgrass Germplasm

TAM-CRD B-1s buffelgrass is an elite sexual plant useful for breeding purposes. It was released to breeders in 1969 by The Texas Agricultural Experiment Station (TAES) and the Agricultural Research Service, USDA (Bashaw, 1969).

As a general rule buffelgrass reproduces by obligate apomixis, an asexual type of reproduction in which seed are formed without sexual fertilization. TAM-CRD B-1s and certain of its offspring comprise the only sexual material of this species available for breeding purposes. TAM-CRD B-1s is presumed to be a sexual mutant from the apomictic Blue variety. It was discovered as a variant plant growing adjacent to fields of 'Blue' and 'T-4464' (Common) buffelgrass on the Pat Higgins Ranch, Sutherland

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Springs, Texas. Method of reproduction, value for breeding purposes, and appropriate breeding techniques were determined through basic cytogentic investigations at College Station.

History and Use

TAM-CRD B-1s is heterozygous for method of reproduction and may be used as the female parent in hybridization with apomictic plants or for production of a variable S_1 population. Selfed progeny segregate for sexuality and obligate apomixis in a ratio of approximately 13:3. Hybridization with apomictic plants gives a ratio of five sexual to three apomictic F_1 progeny (Taliaferro and Bashaw, 1966). Since apomictic S_1 and F_1 plants breed true, superior individuals may be increased and evaluated as potential new varieties.

Vegetative clones and selfed seed of TAM-CRD B-1s are maintained and distributed by The Texas Agricultural Experiment Station.

Higgins Buffelgrass

Description: Higgins buffelgrass (Figure 6-4) is a new variety developed in the

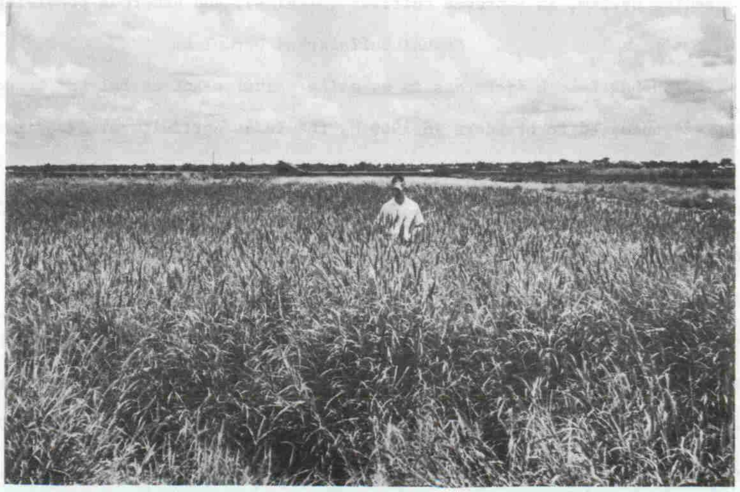

Figure 6-4. Higgins buffelgrass

cooperative grass breeding program of The Texas Agricultural Experiment Station and the Agricultural Research Service, USDA, and released in 1967 (Higgins Buffelgrass, 1968). Higgins possesses a combination of characteristics not found previously in a single variety. It produces a high yield of good quality seed like the T-4464 (common) variety and has the added advantages of higher forage yield, rhizomatous root system, and better persistence. Higgins is recommended as a replacement for the T-4464 (common) and Blue varieties in South Texas.

Higgins is an apomictic selection from the first generation selfed progeny of the sexual plant TAM-CRD B-1s. Since Higgins reproduces by apomixis, it is completely uniform, and its characteristics remain constant. This variety was named in honor of the late Pat Higgins who discovered the original sexual buffelgrass plant and donated it to the cooperating agencies for scientific research.

Higgins buffelgrass has green foliage, brownish-wine colored inflorescences, and a rhizomatous root system. This strain flowers profusely and produces abundant seed heads throughout the growing season. Typical involucres (seed units) of the inflorescence contain a single spikelet, but basal members may have one to four spikelets. Higgins resembles the T-4464 (common) variety in foliage and inflorescence color but may be identified by the rhizomes and its more compact inflorescence. It is distinct from Blue buffelgrass, which has bluish foliage and tan-colored inflorescences.

Adaptation and Performance

Higgins has consistently produced significantly more total forage per acre than common (T-4464) after the seedling year (Table 6-7). The yield and stand of Higgins tend to improve as the rhizomes promote greater spread and better persistence. Higgins does not spread as rapidly as the Blue variety and generally produces less total forage than Blue after the seedling year. Since Blue produces very little seed, Higgins is a more acceptable variety in overall performance. Higgins is intermediate between T-4464 and Blue in cold tolerance and should not be planted in areas where these varieties are subject to winterkilling.

The seed of Higgins as well as other buffelgrass varieties are dormant following harvest and should not be planted in less than 6 months after harvest. If the seed

Table 6-7. Forage yield of buffel and buffel x birdwoodgrass hybrids, Texas A&M University Farm near College Station. Test established in 1968.

Strain	Yield per acre 1968*	1969**	1970***
Buffels			
Common	9,478	6,724	- - -
296	9,457	12,659	8,882
Higgins	8,647	8,390	- - -
1061	8,102	12,491	8,266
Blue	7,840	13,540	10,356
331	7,714	15,498	12,972
300	7,002	12,679	9,374
18-35	6,773	13,534	11,700
1-21	6,408	9,949	8,652
2-1	5,678	10,201	8,013

* Harvested 7/9, 8/7, 9/20
** Harvested 6/12,7/14,8/14,9/15,10/27
*** Harvested 6/29,8/11,11/9. Common and Higgins winter-killed in winter of 1969-70.

are dehulled (removed from the involucres), they will germinate immediately. Thus, earlier planting following seed harvest is possible with dehulled seed.

Prospects for Buffelgrass Improvement

The discovery of a sexual buffelgrass plant and subsequent cytogenetic research provided a basis for a comprehensive breeding program based upon an entirely new concept called apomictic breeding. This research revealed that method of reproduction (apomixis) is genetically controlled by two genes which can be effectively manipulated like any other simple genetic character in an applied breeding program. By crossing the sexual buffelgrass plant as female parent with apomictic buffelgrasses, true-breeding apomictic hybrids can be produced in great numbers. Thus, it is finally possible to combine the desirable characteristics of different buffelgrasses into new F_1 hybrids. Furthermore, apomictic F_1 hybrids remain completely uniform in succeeding generations and can be evaluated immediately as potential new varieties.

One of the most significant prospects of this new breeding program is the possibility of adapting buffelgrass to entirely new areas, such as Central and North Texas, where buffel formerly winterkilled. These areas represent millions of acres where buffelgrass could be a useful species for revegetation and cattle production. By using plants introduced from the high altitudes of South Africa as male parents in crosses TAES has produced

hundreds of new hybrids with potential improvement in cold tolerance. Although only a small proportion of these have been tested in the northern areas, it is apparent that cold tolerant varieties can be developed.

In the limited tests conducted thus far, several hybrids have survived some winters as far north as Knox City, Knox County, Texas. Winter survival in buffelgrass is made possible by the combination of extensive rhizome development and a low degree of tolerance of top growth to cold, resulting in early dormancy. Most rhizomatous buffels developed so far are not prolific seed producers. Seed production will probably present a problem unless this limitation can be overcome through breeding.

Another new development, which involves using apomictic birdwoodgrass as the male parent in crosses, has resulted in significant improvement in seed head characteristics and forage quality. Buffelgrass seed are produced in a bur consisting of seed bearing spikelets surrounded by numerous bristles. The light fluffy bur falls as a unit when the seed matures. Consequently, seed harvest and planting are difficult operations requiring special equipment. Birdwood is a low growing plant of little value for forage, but its burs are compact and can be handled with conventional equipment. By using sexual buffelgrass as the female parent, it is possible to combine good forage production of buffelgrass and the desirable seed characteristics of birdwoodgrass into promising new apomictic hybrids.

Buffel-birdwood hybrids produced thus far are less rhizomatous and less cold tolerant than the better buffel hybrids. However, several of these have outyielded common and Higgins in forage yield tests. *In vitro* digestibility studies have indicated that birdwoodgrass and some of the new hybrids are exceptionally high in dry matter digestibility. Improved seed characteristics and forage quality of these hybrids may actually be more advantageous than exceptional high yield. It is anticipated that strong rhizomes and cold tolerance can eventually be bred into buffel-birdwood hybrids. With the new developments in breeding and expanded testing facilities, future prospects for the use of buffelgrass in Texas are indeed promising.

IMPROVED BERMUDAGRASSES

A. C. Novosad *

Description and History

Bermudagrass, (Cynodon dactylon), is the most important pasture grass in Texas from present use standpoint. Bermudagrass is a long-lived, warm-season perennial with a spreading growth habit and reproduces by runners, root stocks, and seed. It is a native to the Mediterranean region and Southern Asia and was probably introduced into the United States from the Bermuda Islands where, however, it is not a native plant. The presence of bermuda in the United States was recorded as early as 1807. Many acres in Texas are devoted to the Common strain of bermudagrass, which originated from this early introduction. Common bermuda is not a uniform type, but rather represents many different strains which have developed through the years by natural crossing and selection.

Common bermudagrass performs well on adapted soils where fertility and moisture are adequate. In recent years, improved strains and varieties of bermudagrass have been developed with higher yield potentials and more drouth and cold tolerance. Plantings of these have vastly expanded the acreage of bermudagrass in Texas. It is now being grown as far west as the 25-inch rainfall line under dryland conditions and in all other areas under irrigation. Much research work by The Texas Agricultural Experiment Station (TAES) has been devoted to the evaluation of these new strains (Figure 6-5) in regard to adaptation, performance, management, and utilization in various areas of the State.

Adaptation

The improved bermudagrasses, like Common, are highly salt tolerant and will grow on essentially all soils when fertility and moisture are adequate. They do best, however, on loam and sandy loam soils. The growth and production of all bermudagrasses are restricted when grown in poorly-drained, waterlogged soils that remain extremely wet for extended periods. However, Coastal and some of the other strains will tolerate several days of inundation by occasional floods.

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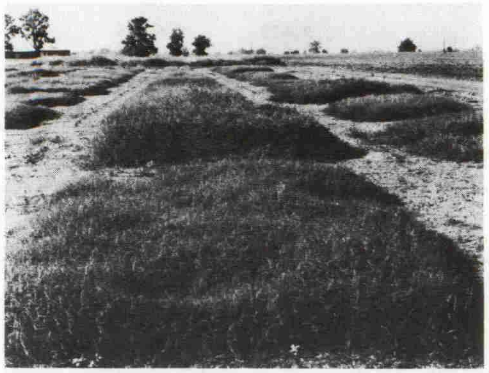

Figure 6-5. Bermudagrass varieties.

The climatic adaptation of the new strains varies due to considerable differences in cold tolerance among the strains. The adaptation of each in this regard is pointed out in the discussion which follows.

The nutritive value of bermudagrasses currently in use and which have been evaluated appears to be similar, with the exception of Coastcross-1, which is considerably higher in value than the others. If properly managed, the quality of forage of all strains is adequate for good performance when utilized in cow-calf enterprises. When established where adapted, stands are productive and will remain productive indefinitely with reasonable care.

The origin and certain characteristics peculiar to the various improved bermudagrass strains are discussed.

Varieties

Coastal bermudagrass is a hybrid developed at the Georgia Coastal Plain Experiment Station by crossing Tift bermuda with a bermudagrass introduced from South Africa. It was the first improved variety released and is the most important from a use standpoint. Coastal has longer leaves and stem internodes and larger stolons and rhizomes than

Common bermuda. It produces few seedheads, which rarely contain viable seed, and therefore must be propagated vegetatively. It spreads by underground stems and aboveground runners that root down at the nodes.

Area of adaptation of Coastal bermudagrass in Texas under natural rainfall conditions is generally east of the 25-inch rainfall line. It is being grown successfully under irrigation in other areas which are below 3,000 feet in elevation. It may winterkill on the High Plains and at higher elevations.

Compared to Common, Coastal bermuda is more drouth resistant and superior in efficiency of water and fertilization utilization. It also has greater resistance to diseases and nematodes. It will produce 20 to 50 percent more forage than Common when management, especially fertilization, is adequate to realize its potential (Trew, 1962). Hay yields from Coastal in various TAES test locations are shown in Table 6-8.

Table 6-8. Yields of hay from Coastal bermudagrass in various Texas Agricultural Experiment Station tests in Texas.

		Irrigated*		
College Station 1954-57	Iowa Park 1960	San Benito 1956-57	Winter Garden 1955-56	Nacogdoches 1956-59
17,180	18,000	20,600	23,920	16,600

*Generally 400 pounds of nitrogen applied plus necessary P, K.

		Dryland*		
Kirby-ville 1960	Mount Pleasant 1956-59	Tyler 1960	Temple 1956-60	Angleton 1957
15,800	9,250	14,000	7,100	21,000

*Generally fertilized with about 200 pounds of nitrogen plus necessary P, K.

Coastal bermuda, like most warm-season perennial grasses, is not considered to have high quality compared with certain other forages, such as cool-season annuals and legmues. Its potential quality and resulting animal performance, however, are much greater than many realize because of the close relationship of quality to management

and utilization practices. Its quality potential is realized when grown under a high level of fertility and harvested at a young, leafy stage of growth (Duble, 1970).

Young animals with limited rumen capacities do not do as well as mature animals on Coastal forage. Grazing data indicate that steers grazing Coastal can be expected to make an average daily gain of about 1.0 to 1.25 pounds for a grazing season (Conrad, 1967, 1972; Norris, 1972). Most of the gain is obtained in the spring with a considerable decline in the late summer months. Such gains are generally considered inadequate for steers. Some grazing trials specifically designed to maintain Coastal under good fertility conditions and managed to supply fresh, young, leafy grass have reported average daily gains of more than 1.5 pounds for a season (Duble, 1970).

Coastal bermudagrass has given satisfactory performance in cow-calf programs, especially with fall-born calves. Research has shown that good quality cows with fall calving, maintained on winter pastures and then on Coastal in the spring, can wean calves weighing 650 pounds by early summer (Rouquette, 1972). In this instance, maximum use is made of the higher quality spring Coastal forage. The lower quality summer growth is adequate for the dry cow. With early fall fertilization, additional higher quality forage growth is stimulated to carry the cattle through the calving season and until winter pastures are ready for grazing. With spring calving on Coastal, fall weaning weights of calves are restricted to about 450 to 500 pounds, even with reasonably good grass management and good quality cattle (McCormick, 1971). The suckling calf gains are good in the spring but decline in the summer and early fall with the declines in forage quality and milk production of the mother cows.

To maintain production of Coastal bermudagrass, fertilization and liming should be geared to production and management practices. Due to the complete removal of forage when harvested for hay, somewhat higher fertilization is needed compared to grazing. A soil test should be used as a guide to fertilizer needs. Nitrogen is generally used with more efficiency when applied after each cutting or grazing period (Tefertiller, et al., 1961). From 40 to 50 pounds of actual nitrogen usually will be needed for each ton of hay or equivalent production. Therefore, an 8-ton annual production level would require about 400 pounds of actual nitrogen.

Midland bermudagrass, a hybrid between Coastal and a cold-hardy Indiana Common variety of bermudagrass, was developed at the Georgia Coastal Plain Experiment Station. It was released and named by the Oklahoma Agricultural Experiment Station. Compared to Common bermudagrass, Midland has a more open sod; longer, taller leaves; and fewer rhizomes. Compared to Coastal, Midland is a darker green color, has stiffer leaves, produces more seedheads, and is more cold-hardy. Midland is considerably more productive than Common bermuda, but equal to or slightly less productive than Coastal in areas where both are adapted (Novosad, 1964).

Midland is used on the High Plains, or above the Caprock, where some winter-killing normally is expected with Coastal. Experiment Station tests have shown it to have no advantage over Coastal in other areas of the State (Table 6-9). Its

Table 6-9. Forage yield of bermudagrass varieties at Mt. Pleasant, Texas 1959-61.[1]

Variety	Pounds of air-dry forage per acre 1959	1960	1961	Average
Midland	9,900	12,800	13,780	12,160
Coastal	8,640	13,160	13,980	11,920
Selection No. 3	8,700	12,800	13,620	11,700
Common	7,440	9,700	11,020	9,380
NK-37[2]		5,600	4,000	4,800
LSD (05)	2,240	1,500	1,440	

[1]Holt and Lancaster, 1968.
[2]NK-37 was seeded in spring of 1960.

establishment, management, and animal performance would be similar to that of Coastal bermuda. Annual forage and animal production are limited by the short summer growing season in its area of use.

Selection No. 3 bermudagrass also was produced by the Georgia Coastal Plain Experiment Station and resulted from the same cross that produced Coastal. Selection No. 3 has shorter internodes, a darker green color, and denser growth than Coastal. This selection was never officially released because work in Georgia indicated that it was less palatable than Coastal and several other selections. Tests in East Texas

(Holt and Lancaster, 1968) have shown its production to be about equal to that of Coastal (Table 6-9). Because of its dense growth, it is being used in East Texas to some extent to stabilize pond dams. There is some use, also, for pasture and hay. Data in regard to nutritive value and animal performance are not available. Selection No. 3 should be established and managed similar to Coastal bermudagrass.

Zimmerly Select was introduced from Northern Rhodesia, Africa, through the U. S. Department of Agriculture Plant Introduction Program in 1955 as P. I. 224693. This plant introduction is known in some localities as "Zimmerly Select bermudagrass." P. I. 224693 is the same genus and species as Common and Coastal bermudagrass. It spreads by both rhizomes and stolons. Trial plantings in Texas starting in 1966 indicate that Zimmerly Select produces about the same amount of forage as Coastal, and its rate of spread is about the same or slightly less (Holt, 1967). Most recent studies indicate that it may be less productive than Coastal (Table 6-10) under some

Table 6-10. Forage yield and dry matter digestibility of experimental bermudagrass varieties, College Station, Texas 1972-75.

Variety	Tons dry matter/acre	In vitro dry matter digestibility (%)
Coastal	17,820	62.6
S-54	17,860	65.2
S-16	19,450	67.8
Coastcross-1	15,160	68.7
Zimmerly Select	13,890	64.7
S-66	20,260	63.8
S-83	16,880	66.2

conditions. It seems to have more erect stems and leaves and to produce more seedheads under certain stress conditions than Coastal. Zimmerly Select has not been subjected to experimental grazing, and no animal response data are available. Research in Louisiana showed the protein content pattern from spring to fall to be similar to that of Coastal. Since Zimmerly Select appears to be adapted to the same areas of Texas as Coastal, its establishment and management would be similar.

Coastcross-1 is a newer hybrid released in 1967 from the Coastal Plain Experiment Station, Tifton, Georgia. Coastcross-1 resulted from a cross between Coastal bermudagrass and a plant introduction (P. I. 255445) from Kenya, South Africa. Coastcross-1 is completely sterile, grows taller, and has broader leaves than Coastal. It has spreading stolons, but few, if any, rhizomes. It is highly resistant to foliage diseases and sting nematode. Its yield is slightly below Coastal, but it has consistently been 11 to 12 percent higher in digestibility than Coastal. Coastcross-1 spreads faster and becomes established quicker than Coastal and makes more fall growth, but is less winter hardy. It is as drouth resistant as Coastal under Texas Conditions. Coastcross-1 is the first bermudagrass to be developed and released for improved quality and animal performance. Although Coastcross-1 is superior in forage quality, some problems associated with this grass, primarily lack of winter hardiness, have limited its use in Texas (Novosad, 1971). It is well adapted in South Texas, generally south of San Antonio, and should be used in that area where bermudagrass is to be established. Winter damage to stands has occurred in all areas of Central and North Texas. Winter survival is enhanced by reducing fertilization and allowing recovery growth in September to permit building root reserves for the winter. In most areas there has been survival of some of the stand with a loss of the late-developed runners and plants. In plantings with 20 percent or more stand survival and with good moisture and fertility conditions, rapid recovery occurs in the springs. Experiences to date indicate that future planting and expanded use of this grass probably will be limited to South Texas.

Some establishment problems are also apparent with Coastcross-1, compared to other bermudas such as Coastal. Since no rhizomes are produced, plantings are made with the above-ground stolons in the spring after growth has begun. The stolons do not contain as much stored energy as Coastal sprigs and will not stand much dehydration. Mechanical sprig planters generally have not worked satisfactorily with the Coastcross-1 stolons, although, with some adaptation, a reasonable job can be accomplished. Most successful plantings are obtained by broadcasting the stolons on a well-prepared seedbed and following immediately with a light disking and rolling. Plantings can be made at any time from spring to early fall whenever moisture conditions are adequate.

Fertilization, weed control, and other management practices are similar to those for Coastal.

African Stargrass, (Cynodon plectostachys) is an introduction from Africa. It is of the same genus as the other bermudagrasses discussed, but of a different species. African Stargrass is coarser than Coastal bermuda and produces few rhizomes. It is a vigorous and aggressive grass when grown in its area of adaptation in South Texas under irrigation. The northern limits of adaptation are not clearly defined, but African Stargrass lacks winter hardiness and is likely to winterkill in most areas other than the Lower Rio Grande Valley. Tests in the Lower Rio Grande Valley have shown its yield to equal that of Coastal and Coastcross-1 bermudagrasses (McBee, 1959; Hoverson, 1972).

Animal performance data are limited, but it is believed to give results similar to Coastal in this regard. African Stargrass is established with rooted stolons like Coastcross-1 bermudagrass. Its management and utilization are similar to those of Coastal bermudagrass.

NK-37 bermudagrass was released by the Northrup-King Company and is an erect, giant strain of Common bermuda that can be established by seed. Compared to Common bermuda, NK-37 grows more upright with less tendency to form a sod and has longer leaves, finer stems, and fewer rhizomes and stolons. It makes rapid growth during the first growing season. In most areas, growth and yields have declined after the first year. It is susceptible to leaf diseases which often reduce its vigor. It can be grown wherever Common bermudagrass is grown, but yields have generally been low (Table 6-9) and often below that of Common bermudagrass (Trew, McBee and Novosad, 1963).

Prospects for the Future

In addition to these major new and improved bermudagrasses which have been evaluated thoroughly or partially by The Texas Agricultural Experiment Station, other varieties which have not been adequately tested are being used. Bermudagrass breeding work at the present is aimed at the development of hybrids with improved nutritive value along with winter hardiness and good yielding ability. Ideally, such a grass would have most of the characteristics of Coastal bermudagrass but with improved quality. It was initially thought that Coastcross-1 might partially fill this need, but its lack of winter hardiness greatly limits its use. Intensive breeding work and development is in progress in Georgia and Oklahoma, with The Texas Agricultural Experiment Station assisting with the evaluation of new developments. Preliminary results with some of these materials are shown in Table 6-10.

SORGHUM HYBRIDS

F. R. Miller *

The Sorghum species, Sorghum bicolor (L.) Moench, contributes significantly to total forage production in Texas, the United States and the world. Those varieties grown in the United States are classified by type and use as grain sorghum, forage sorghum, grass sorghum, sirup sorghum, and broomcorn. The forage and grass sorghums are important for pasture and harvested forages for the cattle industry in Texas.

Origin and History

Sorghum is thought to have originated in the Ethiopian-Sudan region of Northeast Africa and was domesticated there. Following its domestication by a Cushite people about 5,000 years ago, the use of this crop plant has spread throughout Africa and the world. A sorgo type, 'Chinese Amber', was introduced into the United States in 1851. This introduction and those made in 1854 have formed the basis of many forage sorghum types grown in the United States today. Later introductions and hybrids among introduced types have added to the forage production potential of this species.

Sudangrass (Sorghum sudanense (Piper) Stapf.) was introduced into Texas in 1909 from Africa by C. V. Piper of the U. S. Department of Agriculture. A British calvary remount station in the Sudan supplied the seed. This early introduced grassy sorghum, without rhizomes, was named sudangrass and was quickly accepted as an annual grazing crop. Problems with disease susceptibility plagued this newly introduced grassy sorghum from the beginning. Earliest improvement came with the selection of 'Wheeler' from

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the variety 'Common Sudangrass'. But no major improvement was made until 1942 when both 'Sweet Sudan' and 'Tift' were released. Since that time several improved sudangrass types have been developed by Agricultural Experiment Stations throughout the United States. Derivatives of the original introduction are parents of many sorghum x sudangrass hybrids grown on approximately 20 million acres in the United States each year.

The acreages harvested from plantings of forage sorghums grown for bundled or baled hay and silage increased from about 1.75 million acres in 1950 to 2.5 million acres in 1953 but had decreased to about 0.67 million acres in 1971. During this same time the acreages planted to sorgo or grain sorghum x sudangrass hybrids used for grazing or hay increased to 2.0 to 2.5 million acreas annually (Texas Crop and Livestock Reporting Service, 1971). Planted acreage and harvested acreage may not be synonymous since drouth, conservation programs, and other factors may prevent harvesting of some acreages. Both the forage sorghum and the grass sorghum types are grown in all cultivated areas of Texas. The greatest concentration of planted acreages is in the Coastal Bend, Blacklands, Cross Timbers, Rolling and High Plains and the South Central areas of the State. Counties in East Texas and in West Texas average less than 500 acres each.

Types of Forage Sorghums and Their Use

Forage sorghums (Figure 6-6) can be grouped into two general categories based on

Figure 6-6. A field of a forage sorghum hybrid approaching harvest stage.

use and frequency of harvest (Table 6-11). Sorgo varieties, and hybrids with grain

Table 6-11. Types of forage sorghums based on use and frequency of harvest.

Frequently harvested for grazing, green-chop, hay, haylage
Sudangrass
Grain sorghum and sudangrass hybrids
Sorgo x sudangrass hybrids
Sudangrass x sudangrass hybrids
Harvested only one or two times as silage, green-chop or hay
Forage sorghums
Grain sorghums
Sorgo x forage sorghum
Grain sorghums x forage sorghum

sorghum or other sorgo types, produce excellent silage and green-chop. They are not favored for hay production since they produce thick stems which dry slowly. These materials have little value for pastures or frequent cuttings. The hybrids establish quickly, are earlier than varieties, and yield more forage and grain. Prussic acid levels may present problems in this type of forage sorghum.

Sudangrass hybrids and varieties make good pasture and withstand frequent cuttings. They make good hay because of thinner stems which cure rapidly. The sudan hybrids are not as satisfactory for silage production as sorghum hybrids, although they can be used. Prussic acid levels are low and generally cause little concern.

Brethour and Hackerott (1966) state that sorgos are best used for silage and sudangrasses for pasture and hay. The intermediate nature of the grain sorghum x sudangrass hybrids makes them potentially useful in both respects. The grain sorghum x sudangrass hybrids have demonstrated increased vigor, yield, and recovery following harvest over sudangrass varieties. The forage sorghums and the grain sorghum or sorgo x forage sorghum hybrids vary greatly in number of days to maturity, yield, plant height, and stalk size. Within a maturity grouping, the hybrids are higher yielding than varieties, but a late maturing variety may be more productive than an earlier maturing hybrid.

The forage sorghum hybrids are harvested at a later stage of maturity than the sudangrass hybrids in order to obtain maximum total digestible nutrients per acre. At this stage these materials have a low protein content and a maximum energy value. The

sudangrass hybrids are harvested at a younger stage for higher protein content and digestibility, although the energy value is lower.

Development of Forage Sorghums

Forage sorghum types include the sorgos, dual-purpose grain and forage varieties, forage, and sudangrass hybrids. Combine grain sorghums are sometimes used for forage. Those sorgo varieties used before hybrid development form the backlog of male parents of most forage sorghum hybrids today. They have been described by Vinall, Stephens, and Martin (1936) and by Quinby and Marion (1960). These sorgo varieties have been tested in Texas for yield for many years. There is no indication that any particular variety has a peculiar adaptation to any geographical area. However, the correlation between late maturity and high forage yield is apparent when soil moisture is adequate.

Common sudangrass was introduced into Texas in 1909 and is still grown widely. Improved strains have been developed through hybridization with grain or sorgo types with disease resistance and altered maturities. Commonly used varieties in order of maturity are 'Wheeler', 'Common', 'Piper', 'Sweet', 'Tift', 'California No. 23', 'Greenleaf', 'Georgia 337', and 'Lahoma'. Tift shows good foliar disease resistance while Piper and Greenleaf are low in HCN content. Some commercial companies are incorporating resistance to downy mildew and other foliar diseases into their sudangrass pollinators. Work also is underway to increase palatability and dry matter digestibility among sudangrass types.

Hybrid grain sorghum was made possible following the discovery of genetic-cytoplasmic male-sterility in the early 1950's. This story is well presented in "A Triumph of Research -- Sorghum in Texas" by J. Roy Quinby (1971). With hybrid grain sorghum came the possibility of forage and sudangrass hybrids. Much work has gone into the development of grain sorghum hybrids for superior quality factors, but considerably less has been done on forage sorghum improvement. Some sorgo types have been reduced in height and sterilized, but basically the females of today's forage sorghums are not different from those of the 1960's. The primary concern is one of high seed production in the seed fields. As a result 'Redlan' and single-cross females among 'Combine Kafir' types predominate in forage sorghum and sudangrass hybrids because of their yielding ability as seed parents. Some sorgo types have been sterilized by both State Agricultural Experiment Stations and commercial seed companies for use in hybrid forage sorghums; however, their use is not widespread.

Forage sorghum and sudangrass hybrids have not completely replaced standard varieties of forage sorghums as did hybrid grain sorghums. Nevertheless, there are a large number of hybrids on the market, and their quality characteristics are being improved. The future forage hybrids will be superior in disease resistance and in nutritive quality.

Hybrids will produce at least 20 to 50 percent more forage per acre than related varieties under similar management conditions (Tables 6-12 and 6-13). Hybrids appear

Table 6-12. Yield of forage sorghum hybrids and varieties in Texas.

	Tons of air-dry forage per acre					
	Mt. Pleasant 1962-64	Tyler 1962-64	McGregor 1963-64	Temple 1963-64	Col. Sta. 1962-64	Chillicothe 1952-59
			Forage sorghum hybrids			
Lindsey 101F	6.7	2.8	4.5	5.0		
Dairy D	4.7		4.4	4.2		
Aztec	5.7		5.0	5.5		
Milkmaker	4.9		5.0	5.7	6.6	
Lindsey 92F	4.2	2.5	4.5			
Crop Guard	3.8	2.6	4.6	4.2	4.9	
Silo King	3.6		4.5		5.4	
Beef Builder T	6.3			5.7		
FS 1A	4.7	2.0	4.1		4.5	
FS 22	4.2	2.7	5.0	5.3	5.8	
3 Little Indias		2.8	4.0			
Beef Builder R				6.0		
Yieldmaker				5.6	6.4	
Lindsey 115F		3.4				
HO-K		3.1				
A606 Comb. Kafir x Kans. Orange						7.81
A385 Comb. Kafir x Atlas						6.10
A378 Redlan x Kans. Orange						5.82
A606 Comb. Kafir x SA3						12.00
A378 Redlan x SA3						10.06
A606 Comb. Kafir x SA1306						10.26
A378 Redlan x SA1306						12.06
		Varieties				
Sart	5.1		4.6	5.3	7.7	6.94
Atlas	4.4	1.9	3.0	3.8	4.3	5.69
Tracy			4.5	4.4	6.0	
Honey				4.7	6.0	6.46

Holt, 1965.

Table 6-13. Yield of forage produced by grain sorghum or sorgo x sudangrass hybrids and varieties in Texas.

	Yield (pounds per acre)				
Variety or hybrid	Mt. Pleasant 1962-64	McGregor 1962-64	Temple 1962-64	Col. Sta. 1962-64	Chillicothe 1952-59
	sorghum or sorgo x sudangrass hybrids				
Grazer W	2,470	8,200	7,405	12,150	
Sweet Sioux	1,790	8,230	8,280	12,260	
Haygrazer	2,070	8,040	6,930	12,450	
Kow Kandy	2,590	7,500	6,790	11,840	
Sudax 11	2,280	7,660	7,340	12,980	
Green M	2,220	8,340	6,930	12,060	
Grazemaster	1,880	8,340	7,380	11,540	
Six Shooter	1,760	8,170	6,580	11,000	
Sordan	2,090	9,490	7,010	11,660	
Grazer A		9,200	7,110	11,550	
Lindsey 77F		8,810	6,400	10,920	
Golden Sue		8,760	7,220		
Leafy Sue		7,850	6,930		
Pioneer's 980			6,710		
A378 Redlan x Piper					12,080
A378 Redlan x Sweet					11,040
A605 Comb. Kafir x Piper					10,760
A398 Martin x Sweet					10,280
A605 Comb. Kafir x Sweet					9,160
		Perennial sorghum grasses			
Sorghum almum	1,310	5,800	5,060	12,090	
Perennial Sweet Sorgrass	1,500	4,320	3,230	9,930	
Johnsongrass			3,070		
		Sudan varieties			
Piper	2,000	5,800	4,740	10,640	
Greenleaf	1,820	5,470	4,995	9,170	
Sweet	1,700	5,280	3,425	8,030	
Common	1,695	3,920	4,220	10,570	

Staten and Holt, 1965.

to be more resistant to foliar diseases but higher in prussic acid content than varieties. Hybrids appear to be chemically similar and give similar performance. The correlation between late maturity and high forage yield is expressed when soil moisture is adequate.

Hybrids involving grain sorghum females usually are made with Redlan or single-crosses as the female. When single-crosses are utilized, both parents may be grain sorghum lines or one may be a short-statured, sweet and juicy stemmed sorgo. Pollinators used in the forage sorghum hybrids are generally 'Hegari' or hegari derivatives. Other varieties, such as 'Atlas', 'Rox Orange', and 'Sumac', are used as male parents also. In the sudangrass hybrids at least four types of females are used: grain sorghum lines, single-crosses, sorgos, and true sudans. Sudangrass pollinators are generally 'Piper', 'Greenleaf', and 'Sweet'. The widespread use of these varieties as pollinators for grain sorghum or sorgo x sudangrass hybrids can be attributed to their palatability and lower HCN content. Other released and private types are used also.

Weedy Sorghums

Off-type sorghum plants have been described by Clark and Rosenow (1968). The single most important aspect of forage sorghum production related to the weedy sorghum problem is the sorgo or grain sorghum x sudangrass hybrid.

Seed contributing to the volunteering problem of the sorgo or grain sorghum x sudangrass hybrids come from previous forage production areas, either grazed or diverted acreages. These volunteer sorghums should not be allowed to mature in forage production areas. Rotation programs, herbicides, and roguing measures may be used to insure against the escape of these sorghums to become weeds in other crops.

SMALL GRAINS

M. E. McDaniel*

In many areas of Texas, small grains provide the primary source of green forage during the winter and early spring months. They are easily established and generally provide dependable production and high yields. The Texas acreage of small grains grown for forage exceeds that of any other winter grazing crop. The majority of the 6 to 8 million fall seeded acres of small grains is used to some degree for late fall, winter, and early spring pasture each year. Probably at least 25 percent of the total acreage is seeded exclusively for forage use with no intention of producing a grain crop.

Use

The increased demand for feeder cattle, due at least in part to the tremendous growth of the feedlot industry on the Texas High Plains, has caused an increased interest in the intensive or exclusive use of small grains for winter forage. The use

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of small grains in East Texas and irrigated wheat in the Texas High Plains exclusively for forage increased dramatically in the late 1960's. There are indications that the potential of these systems has not yet been reached. Some of the wheat acreage is planted as early as mid-August to produce forage before the onset of cold weather.

Per-acre returns from grazing small grain can be very high if good fertility and moisture are available and good grazing management practices are followed. Animal gains of 300-500 pounds per acre are reported regularly from full-season grazing of irrigated wheat on the High Plains and in the Trans-Pecos area (Shipley, 1973). Much higher production has been reported recently from early-planted and intensively managed irrigated wheat. Liveweight gains of 200-400 pounds per acre have been reported on dryland small grain used for grazing in Central and East Texas (Norris, 1967; McCartor and Taylor, 1970). Most of the crop harvested for grain also is utilized for early-season grazing. Grazing provides additional income from the crop without seriously reducing grain yields if proper management practices are followed. Therefore, small grain forage is providing a major source of income for farmers and ranchers throughout Texas.

Adaptation

Small grains used for forage in Texas include wheat, oats, barley, and rye. Limited acreages of triticales and other "man-made" crops such as male sterile wheat x agrotricum also have been utilized for forage in recent years. Rye appears to be better adapted to the lighter sandy soils than the other small grains. However, all small grains require high soil fertility to promote maximum growth, high nitrogen levels being particularly important for the production of good forage yields. Although a range of winter hardiness exists within each species, well-defined differences in cold tolerance also occur among the different small grains. Wheat and rye are the most tolerant of cold temperatures, and these crops are favored for grazing in the High Plains and Rolling Plains areas of Texas. Barley is intermediate in hardiness but can be grown successfully in the High Plains area. However, both barley and most available triticale varieties are more susceptible than wheat to damage by the combined stresses of grazing and cold injury. Oats are the least winter hardy of the small grains and are best suited for grazing in the more temperate areas of the State.

Since small grains are grown over such a wide area of Texas under a wide range of environmental conditions, varieties having different characteristics are necessary for successful production in different locations. Length of the forage production period and the growth pattern during the period are influenced by varieties. Varieties differ in growth type (Figure 6-7), winter hardiness, maturity class, and disease and insect reaction. These agronomic characteristics determine the forage production pattern and the ability of the plant to recover following grazing. Some upright-growing spring-type varieties are almost totally unsuitable for sustained grazing. Although these varieties produce abundant early forage, they are susceptible to severe grazing damage because the early elevation of the growing point subjects it to removal by grazing.

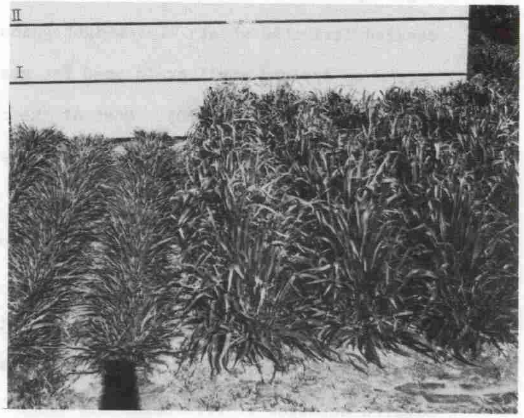

Figure 6-9. Winter and spring type small grains.

Extremely prostrate (winter-type) varieties produce very little fall and winter forage unless planted extremely early. However, some cold-tolerant varieties have more upright growth and produce more early forage than the extremely prostrate types. Varieties combining good winter hardiness with semi-upright growth habit are favored for forage use in cold areas. In the more temperate areas of South and Central Texas, varieties which have intermediate growth habit and which produce moderate early forage growth are preferred.

Although choice of variety is a very important consideration, proper grazing management is essential for efficient utilization of the forage. In general, grazing studies on small grains have shown most efficient animal gains when the stocking rate

was light enough to allow production of surplus forage under a continuous grazing system. Therefore, stocking rate is very important, and grazing management usually has proved to be of greater consequence than varietal differences in small-grain grazing tests when well-adapted varieties have been compared (Norris and Kruse, 1967).

Varieties

Variety adaptations change rapidly primarily because of changes in disease susceptibility with the development of new races of rust pathogens and with the development of new varieties. Thus, the listings in Table 6-14 of adapted varieties serve only as a

Table 6-14. Recommended small grain varieties for forage use in Texas.

	High Plains	Rolling Plains	North Central	Central	East Texas	Gulf Coast	Edwards Plateau	South Texas	West Texas
Wheat									
Blueboy II		x	x	x	x	x	x	x	x
Fox			x	x	x	x	x	x	
Sturdy	x	x	x	x	x	x		x	x
Milam								x	
Arthur 71			x	x	x	x			
Riley 67			x	x	x				
Coker 68-15			x	x	x	x	x	x	
Agent			x	x	x				
Caddo			x				x		
TAM W-101	x	x							x
Centurk	x	x							
TAM W-103	x	x							x
Tascosa	x								
DeKalb 9290[1]	x	x							x
Oats[2]									
Coker 234				x	x	x	x	x	
Coker 227			x	x	x	x	x	x	
TAM O-301						x		x	
TAM O-312				x		x	x	x	
Fla. 501				x			x		
Coronado				x			x		
Cortez				x		x	x	x	
New Nortex			x	x	x		x		
Ora			x		x				
Nora			x		x				

Table 6-14. Recommended small grain varieties for forage use in Texas (cont'd.)

	High Plains	Rolling Plains	North Central	Central	East Texas	Gulf Coast	Edwards Plateau	South Texas	West Texas
Barley									
Luther	x	x							x
Will	x	x							x
Tambar 401		x	x	x	x	x	x	x	x
Cordova				x	x		x		
Fla. 102						x		x	
Era		x	x				x		x
Rye[3]									
Elbon	x	x	x		x				
Bonel	x	x	x	x	x		x		x
Balbo	x				x				x
Wintermore			x	x	x		x		
Acco WR 811		x	x	x	x		x		
Vitagraze			x	x	x		x		
Triticale									
Fas Gro 131[4]	x	x	x	x	x	x	x	x	x
Fas Gro 385		x	x	x	x	x	x	x	x
Fas Gro 208				x		x		x	

[1]Sterile wheat-grass hybrid produces abundant late forage but no grain. Limited early forage production.

[2]Oats usually produce higher forage yields than other small grains in South and South-Central Texas. Oats generally lack sufficient winter-hardiness for dependable forage production in the High and Rolling Plains

[3]Rye produces good forage yields in North and East Texas but matures too early for sustained forage production in South and South-Central Texas.

[4]Produces large amount of late season forage. Early forage production limited.

current guideline. The listing gives some indication of species adaptation but is not necessarily inclusive of all adapted or suitable varieties.

Problems and Needs

Diseases are of major importance for both forage and grain production in South Texas but are less serious in Central and East Texas and the Rolling Plains. In South Texas, leaf rust of wheat frequently reduces the quantity and quality of forage. Re-

cently, additional wheat acreages have been grown in this area and in Mexico, and wheat leaf rust problems have increased in severity. Crown rust of oats is a serious recurring problem in the Coastal Bend area of South Texas. Both diseases may shorten the grazing period drastically if severe epidemics occur.

Although plant breeders have developed varieties resistant to the rust pathogens, changes in the disease organism frequently overcome the resistance and make the variety useless after a relatively short period. The effective "lifespan" of oat varieties is only 3-5 years in South Texas. In the last 10 years, at least seven previously resistant oat varieties have become susceptible to crown rust in South Texas. There also appears to be a trend toward more rapid rate of development of disease organisms capable of attacking previously resistant wheat varieties. Although new breeding approaches offer some potential for producing more stable resistance, rust diseases probably will continue to affect forage yields to some degree. Resistant varieties offer the only practical protection against rust diseases at present. In extreme cases it may be necessary to use a different crop until new resistant varieties of the preferred species become available.

Insects which cause severe losses in some seasons generally must be controlled with insecticide applications. However, barley varieties with genetic resistance to the greenbug aphid are available (Will, Era, Tambar 401). Oat varieties with resistance to the greenbug also are being developed and should be available within a few years.

Future Outlook

More emphasis is being placed on breeding small grains for forage. The primary objective of ongoing research is the development of varieties and hybrids which excel in dependable forage production at different periods during the growing season. Small grain varieties now being grown, with the exception of rye, were bred and released for grain production and grain quality. Forage characteristics were considered to be of secondary importance and were not used as a major criterion for selection. Until recently, farmer-stockmen were not variety-conscious when forage production was the primary objective. However, both seedsmen and growers are becoming aware of the differences among varieties for forage production.

As a part of the breeding program, effort is being devoted to breeding and evaluating small grain hybrids and derivatives of crosses involving different species -- primarily those among wheat, rye, triticale, and agrotricum. The development of male sterile wheat made possible the hybridization of these natural and man-made species. Male sterile wheat x agrotricum crosses have shown considerable promise in preliminary tests. Sterile wheat x wheat hybrids also have produced more forage than the parent varieties. Other combinations being studied include 1) male sterile wheat x agrotricum x 6X triticale derivatives, 2) triticale x agrotricum derivatives, and 3) male sterile wheat x rye x 6X triticale derivatives. More than 800 lines from the male sterile wheat x rye x 6X triticale are being studied. These lines are essentially 42-chromosome triticales, and some appear quite promising as they have winter growth habit and better winter hardiness than most presently available triticales. Recently discovered cytoplasmic male sterility in rye also offers exciting potential for improvement of this crop by controlled hybridization. The male-sterile cytoplasm is being transferred into adapted rye germplasm at present.

Both private and public plant breeders are becoming more involved in breeding for forage production in small grains and are utilizing a much wider germplasm base than ever before in these breeding programs. Thus it is probable that small grain forages will be appreciably improved within the next few years.

LEGUMES

G. W. Evers*

Legumes, compared with grasses, are of minor importance in Texas for several reasons. At present, there are only a limited number of forage legumes which are adapted to the various climatic conditions of the State. The legume-bacteria relationship and the legume-grass relationship of mixtures require more exacting management than a grass pasture. The management requirement does not mean additional work, but a greater knowledge and understanding of the legume plant and its ecology.

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Use and Value

A good grass-legume mixture is more desirable than a grass alone for pasture in terms of costs and animal performance. The associated bacteria within a nodulated legume take nitrogen from the air. The nitrogen is not only available to the legume plant but also becomes available to the grass plant. Therefore, the cost of nitrogen fertilization is reduced.

Dry matter digestibility is higher for the temperate legumes than for any other class of forages. Animal performance (beef or milk production) from a pasture containing legumes is higher than from a pasture containing only grasses (Riewe, 1966). Tropical legumes which grow during the summer are equal to the warm-season perennial grass in digestibility when the plants are young. Moreover, with increasing maturity, digestibility decreases less in legumes than in grasses.

Legume-grass combinations, such as dallisgrass-white clover also can extend the grazing season; this reduces labor and machinery costs involved in the production, handling, storage, and preservation of feed. Legumes also are beneficial in terms of soil conservation and soil fertility, and probably so in reduced nitrate movement in the soil, compared with inorganic nitrogen sources.

White Clover

Louisiana S-1 white clover (Figure 6-8) is the major forage legume in Southeast Texas. It is well adapted to the heavy, poorly drained soils and high rainfall of the area. Although white clover is a perennial, it usually acts as a cool-season annual because of the hot and sometimes dry summers. Peak forage production occurs

Figure 6-8. Louisiana S-1 white clover

in late winter and spring while summer production is limited and dependent on moisture. New growth in the fall results from seed produced during the preceding season and sometimes from surviving plants.

Louisiana S-1 is seeded in the fall at 2-4 pounds per acre in sod that has been cut or grazed short, or on a prepared seedbed. October seeding is preferred, but both earlier and later seeding may be successful (Table 6-15).

Table 6-15. Influence of seeding date on dry matter production (lb/ac) of Louisiana S-1 white clover (three-year average 1962-65).

Date seeded	Clipping dates: 30 Nov.	11 Jan.	17 Mar.	19 Apr.	Total
September 1	546	991	1,525	1,114	4,176
September 15	385	669	1,574	1,129	3,757
October 1		1,596	1,808	1,224	4,628
October 15		802	1,893	1,071	3,766
November 1		214	1,761	1,105	3,080
November 15			1,852	1,137	2,889
December 1			945	1,130	2,075

Craigmiles and Weihing, 1971.

Climatic conditions may be more important than varieties in influencing clover production (Table 6-16). Rainfall was 13 inches above normal in 1966 for the Beaumont

Table 6-16. Annual forage production of white clover at Beaumont as influenced by season and age of stand.

Year of production	Year of planting: 1963 La S-1	1963 Regal	1964 La S-1	1964 Regal	1965 La S-1	1965 Regal	1966 La S-1	1966 Regal
1964	3,940	5,170						
1965	5,770	4,800	7,830	6,750				
1966	10,570	12,820	8,910	9,380	6,220	6,410		
1967	4,130	4,540	3,910	4,130	4,970	4,460	5,000	5,710

Craigmiles, Brown and Weihing, 1965.

area, and forage yields were exceptionally high. It appears that the limiting factor to white clover production is lack of moisture. Irrigation of white clover-grass pastures may be an economical method to increase production.

Louisiana S-1 white clover responds favorably to close utilization because it is short growing and maintains adequate leaf development near the ground level (Table 6-17).

Table 6-17. Effect of cutting height and frequency on forage production of Louisiana S-1 white clover and Abon Persian clover (three-year average 1962-65).

Cutting Frequency (wk.)	Cutting Height (in.)	Louisiana S-1 White clover	Abon Persian clover
1	2	2,777	2,788
	5	2,445	2,602
2	2	3,668	3,118
	5	2,867	3,028
3	2	3,212	3,942
	5	2,435.	3,187
4	2	3,841	4,634
	5	2,515	2,811

Craigmiles and Weihing, 1971.

Additionally, close utilization would reduce competition from grasses and weeds.

Persian Clover

Persian clover is a winter annual legume which is adapted to the southern United States where it is primarily used for pasture and hay. It does best on heavy, moist soils in low-lying areas.

Abon Persian clover was developed by R. M. Weihing at The Texas Agricultural Experiment Station at Beaumont and released in 1964 (Abon Persian Clover, 1964). Abon can be grazed 4 to 8 weeks earlier in the fall and 4 weeks later in the spring than common Persian clover. Seed yields are about 300 pounds per acre. Abon seldom lodges and does not shatter its seed before or during harvest.

Seeding at the rate of 5 to 8 pounds per acre in the fall produces adequate stands. October seeding is preferred (Table 6-18), but earlier seeding produces more

Table 6-18. Influence of seeding date on dry matter production (lb/ac) of Abon Persian clover (three-year average 1962-65).

Date Seeded	Clipping date: 30 Nov.	11 Jan.	17 Mar.	19 Apr.	18 May	Total
September 1	889	894	1,196	1,336	837	5,152
September 15	630	823	1,249	1,469	983	5,154
October 1	251	1,587	1,728	1,511	1,157	6,234
October 15	124	571	1,755	1,630	1,250	5,330
November 1		296	1,713	1,590	1,212	4,811
November 15			1,565	1,393	1,147	4,105
December 1			763	1,082	903	2,748

Craigmiles and Weihing, 1971.

fall growth. Abon is not highly sensitive to cutting or defoliation intensity, but maximum production is obtained with less frequent harvesting than with Louisiana S-1 white clover (Table 6-17). During 1963, a very dry spring, yield of Abon was over three times that of Louisiana S-1 at the low cutting height. However, white clover can be productive during the summer when adequate moisture is available, while Persian clover dies in June. Hard seed content of Abon has been improved (Weihing, 1962) to insure adequate volunteer stands in the fall.

Sweetclovers

Sweetclovers are more drouth tolerant than other forage legumes and perform well on the blackland soils in Central Texas. Most varieties of sweetclover are not adapted to East Texas because they do not tolerate acid soils. Sweetclovers are used predominantly as soil improvement crops because they produce large amounts of dry matter and develop strong taproots which open up the subsoil.

Sweetclover leaves contain a compound called coumarin which gives the forage its characteristic bitter taste and its sweet smelling aroma when cut. High coumarin content reduces the palatability of the forage and may reduce the clotting ability of the blood in animals fed spoiled sweetclover hay. New varieties are being selected for low coumarin content.

'Israel' sweetclover is an annual white sweetclover which was introduced from Israel as Plant Introduction No. 200355 (Israel sweetclover, 1958). It resembles Hubam sweetclover but is larger and approximately 4 to 6 weeks later maturing than Hubam. It is restricted to South Texas since low temperatures (18° F) in late fall have caused leaf damage. Spring planting is recommended for Central and North Texas.

Under adequate fertility and moisture, Israel sweetclover has produced over 10 tons of dry matter per acre on the A&M Plantation near College Station. These high yields are partially due to its long growing season from October to early August. Hubam and Floranna sweetclovers are slightly higher yielding until late spring.

Tropical Legumes

The potential of tropical legumes in Texas is being studied at College Station and at The Texas Agricultural Experiment Station at Beaumont and Angleton. As the name

implies, these legumes are native to tropical areas primarily in Central and South America and Africa and are likely to be adapted only in areas with mild winters. Species with various growth habits have been obtained.

Stylosanthes species, commonly referred to as stylo's, form a low growing sod which resembles lespedeza. Desmodium species have larger leaves and produce runners which trail on the ground but with branches which reach a height of 2 to 3 feet. Most of the tropical legumes produce creeping stems which will root when in contact with the soil or will twine around other up-right growing plants. Like other legumes, they have the ability to obtain nitrogen from the air through associated bacteria living in nodules on the legume roots. Except for one species, tropical legumes do not cause bloat in livestock.

Siratro (Figure 6-9), one of the tropical legumes, has been grown in a mixture with Kleingrass at College Station (Siewerdt, 1972). Dry matter production of the mixture was equivalent to that of a pure stand of Kleingrass fertilized with 100 pounds of nitrogen.

These tropical legumes are being evaluated for adaptation to Texas conditions. The better adapted varieties will then be evaluated in mixtures with various grasses under clipping and grazing.

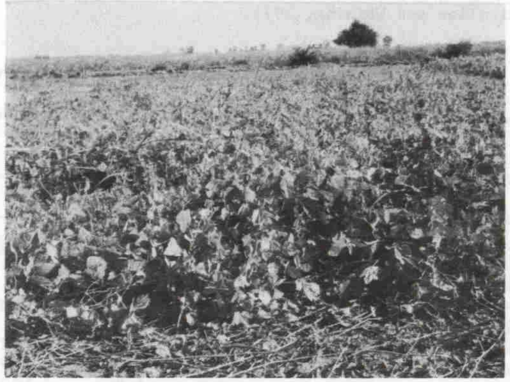

Figure 6-9. Siratro

Alfalfa

Alfalfa is the most important forage legume grown in the United States. In 1970, more than 27 million acres of alfalfa and alfalfa mixtures were harvested for hay in the United States, with 200,000 acres in Texas (Yearbook Statistical Committee, 1971).

Alfalfa is best adapted to deep soils which are well drained. Acid soils require lime for good production. It does well in dry climates with irrigation and good fertility. Adapted varieties in the Lower Rio Grande Valley have produced over 7 tons of dry matter per acre (Matocha and Cowley, 1965). Limited production information (Table 6-19) shows potential adaptation of several relatively new varieties to river bottom soils of Central Texas.

Table 6-19. Forage yield of Alfalfa Varieties, A&M University farm near College Station, 1974.

Variety	Pounds of dry forage per acre[1]				
	May 25	June 28	Aug 5	Oct 18	Total
Arizona RON	5,334	3,562	1,701	862	11,459
Certified El Unico	5,732	2,971	1,576	1,104	11,383
Certified Sonora 70	5,613	3,101	1,392	1,137	11,243
Mesilla	5,421	3,266	1,490	864	11,141
Certified Mesa-Sirsa	5,249	2,978	1,697	1,076	11,000
Victoria	5,225	3,305	1,403	931	10,864
Team	5,162	3,363	1,358	923	10,806
Certified Hayden	5,222	2,877	1,631	982	10,712
Weevilchek	5,162	2,988	1,259	867	10,276
Cherokee	4,857	3,223	1,199	1,207	10,486
Common (local)	5,195	2,834	1,403	1,000	10,432
Fla 66	4,790	3,175	1,171	1,095	10,231
Zia	4,641	2,844	1,695	1,031	10,211
Certified Sonora	4,768	2,632	1,279	1,067	9,746

[1]Test was planted December 12, 1973.

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