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The Texas Agricultural Experiment Station,
J.E. Miller, Director,
Texas A&M University System
College Station, TX

CHAPTER 1

DEVELOPING IMPROVED GRASSES AND LEGUMES

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CHAPTER 1

DEVELOPING IMPROVED GRASSES AND LEGUMES

E. C. Holt and E. C. Bashaw*

Grasslands occupy a prominent place in Texas and the Nation. Pasture and harvested forages form the base of the beef cattle industry, which has the highest annual gross income among all farm commodities in Texas. In addition to serving as the sources of roughage for the livestock industry, grasslands contribute to soil and water conservation, wildlife, and recreation. The objectives of the grass and legume development programs of the Texas Agricultural Experiment Station include all these aspects.

With soaring land prices, high capital investment, and declining net farm income, it is imperative that adapted grasses and legumes with high yield potential, efficiency of production, high-quality forage, and suitability for wildlife, especially wild fowl, as well as for domestic animals, be available for range and pasture seeding. Although there are a large number of species in the State, no one possesses all the characteristics necessary to meet these requirements.

Because of the variable rainfall patterns in the State, it is highly desirable that grasses and legumes be able to withstand extended periods of drouth, yet be able to respond rapidly when moisture becomes available. Establishment of warm-season grasses, except in the extreme southern area of the State, normally is in the spring and early summer. Weed competition is at a peak at this time, and moisture deficits in the surface layer of soil are common. Thus, adapted grasses should germinate rapidly and possess vigorous, hardy seedlings in order to compete with weedy plants. Furthermore, established stands should persist for long periods to assure reliable and contin-

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*Respectively, professor, The Texas Agricultural Experiment Station (Department of Soil and Crop Sciences); research geneticist, Agricultural Research Service, U.S. Department of Agriculture (Department of Soil and Crop Sciences).

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uous production. In addition to drouth tolerance, cold tolerance, response to moisture, seedling vigor and forage quality, efficiency of production and utilization are further enhanced by persistence, high-quality seed for establishment, large seed for wild fowl, and numerous other favorable characteristics.

The warm-season grasses are generally grown in single species stands. Forage quality is low in late summer and early fall. Animal performance frequently is poor during this period, and actual weight losses may occur with young animals. Obviously, improved forage quality is needed, and recent research has shown that breeding for quality is feasible.

An extensive and continuing grass breeding program is the only way to meet the demands and requirements for grass varieties designed for specific conditions and situations. Improvements in forage production can be made through agronomic practices, but these require continued cost inputs. In contrast, improvements induced through breeding require no further inputs by the producer following establishment in order to realize the benefits of those improvements. Seed of improved varieties may cost more than common or unimproved sources for initial stand establishment. Certainly not all problems can be solved through breeding, but for those that can be, the solution is economical and efficient.

BASIC STUDIES

Development of a sound and productive plant improvement program requires a thorough knowledge of method of reproduction, cytology, and taxonomic relationships of the species concerned. Fundamental cytogenetic information is vitally important in grass breeding because of the prevalence of apomixis and many irregular cytological phenomena. This type of information is generally common knowledge for most crop plants but has often been taken for granted in the forage grasses. The problems confronting the grass breeder are many and varied, ranging from purely physical limitations to the most complex reproductive processes known. The small size and delicate nature of the grass floret limit practical use of the mass hybridization approach and prohibit economical production of hybrid varieties in most species. Thuse far, there have been few cases of successful use of male sterility in the forage grasses. Polyploidy, irregular

meiotic behavior and fertility problems are especially prevalent in the perennial grasses. It is imperative that the geneticist understand the basic nature of these problems and explore all possibilities for efficient plant breeding.

Apomixis, asexual seed formation, is particularly troublesome in grass breeding and has prevented improvement of some of our most important species, including dallisgrass, lovegrass, bahiagrass, buffelgrass, sideoats grama and the bluestems. Apomixis is a vegetative method of reproduction in which the embryo of the seed is formed without the union of egg and sperm nuclei as occurs in normal sexual plants. Apomictic embryos develop from cells of the vegetative tissue inside the ovary and produce plants identical to the parents, as occurs with propagation from buds or rhizomes. The pollen serves only to stimulate development or induce endosperm formation. Thus, apomixis is essentially a vegetative form of seed development.

Some plants, known as obligate apomicts, produce all of their seed vegetatively, while others, called faculative apomicts, are capable of some degree of sexual reproduction. The offspring of obligate apomicts are completely uniform and identical to the parent clone. Thus, there is no variation from which to select new types, and improvement is limited to discovery of different natural apomicts in the species. Since the male sperm does not enter into the apomictic reproductive process, hybridization is impossible unless there are sexual plants of the species. Once sexual plants are discovered, they generally may be used as female parents in crosses with apomicts of the same species. Scientists now believe that it is possible to find sexual plants in most apomictic species, and this has been shown to be true in a number of forage grasses.

The importance of basic information to a grass breeding program is illustrated in the early experience with common dallisgrass. Efforts had been made for years to improve this grass, using conventional breeding procedures without success. Early work in the program (Bashaw and Holt, 1958) of The Texas Agricultural Experiment Station (TAES) showed that common dallisgrass is an obligate apomict, therefore not subject to improvement by the usual techniques. Cytogenetic studies of dallisgrass provided useful information on the breeding of apomicts, but more importantly, showed the importance of basic information in grass breeding programs. The fact that abnormal reproduction is prevalent in perennial grasses has led to method-of-reproduction studies becoming an integral part of the TAES breeding program. Furthermore, these basic studies provide information on the mechanism involved in the reproductive process and the potential for utilizing apomixis in the development of improved varieties. The most extensive work of this type has been done with buffelgrass.

The first efforts to determine mode of reproduction in buffelgrass and the possibility of developing a breeding program were initiated in 1951. Extensive cytogenetic investigation of buffelgrass and birdwoodgrass showed that both species reproduced by obligate apomixis (apospory) (Fisher, Bashaw and Holt, 1954; Bashaw, 1962). Thus, hybridization was impossible, and selection of potentially useful plants was limited to the different apomictic accessions introduced from Africa. Cold-tolerant accessions with acceptable seed production were never recovered in the evaluation program, and no significant progress was made until the discovery of a sexual buffelgrass plant on a Texas ranch in 1958. Pat Higgins observed a volunteer plant with rhizomes and numerous inflorescences growing near commercial plantings of the Common and Blue strains on his ranch at Sutherland Springs. Mr. Higgins found that seedlings from this plant were variable, indicating sexual reproduction had taken place.

Cytological studies of the sexual plant revealed normal embryo sac development with no evidence of apospory, which always had been observed in other buffelgrass accessions. Subsequent evaluation of its progeny showed that the plant reproduced sexually but was heterozygous for method of reproduction. Both sexual plants and obligate apomicts were present among selfed progeny of the sexual plant. When crossed with apomictic accessions, both sexual and apomictic F_1 hybrids were produced (Figure 1-1). Inheritance studies showed that method of reproduction was genetically controlled in buffelgrass and that obligate apomixis could be manipulated effectively in a planned breeding program (Taliaferro and Bashaw, 1966).

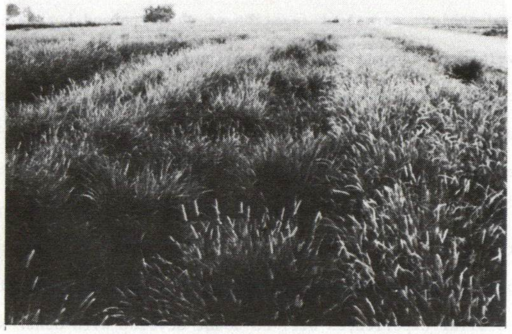

Figure 1-1. Buffelgrass breeding nursery showing variable progeny rows from sexual reproduction (center) and uniform progeny rows from apomictic reproduction (left and right).

Since obligate apomicts breed true, any promising apomictic hybrid is a potential new variety, and no further selection is required to achieve uniformity (Figure 1-2).

Figure 1-2. Buffelgrass

By using the sexual plant as the female parent and pollen from selected apomictic accessions in crosses, it was possible to combine the desirable characteristics of the parents and achieve permanent fixation of genotype and heterosis in apomictic F_1 hybrids. Development of an efficient crossing technique permitted rapid production of an unlimited number of new apomictic hybrids for immediate evaluation. Segregating progenies from sexual hybrids and backcrosses with apomicts provided abundant additional sources of new apomictic plants.

Not all basic studies have the immediate practical application found in buffelgrass. Efforts to manipulate the method of reproduction in dallisgrass have not been successful, but the basic information is available when suitable plant materials are discovered. Similar experiences will no doubt develop with other species.

IMPROVED VARIETIES

Significant progress has been made in the improvement of several species and in basic studies with the same and other species. This work included both the development and release of varieties and the development of information related to breeding behavior, breeding procedures, and breeding needs.

Early work in Texas included the development and release of 'Texas 46' rescuegrass (Warner and Hensel, 1947) and 'Texturf 1F' and 'Texturf 10' bermudagrasses (Turfgrasses, 1958). More recently, variety development was included 'Gulf' ryegrass (Gulf ryegrass, 1958), Abon persian clover (Abon, 1964), 'TAM Wintergreen' hardinggrass (Norris et al., 1968), 'Higgins' buffelgrass (Higgins, 1968), 'TAM-CRD 1s' buffelgrass (Bashaw, 1969) (the latter as an elite clone for breeding purposes), 'Kleingrass 75' (Holt, 1969), 'Israel' sweet clover (Israel, 1958), Cogwheel burclover (Cogwheel, 1956), 'Premier' sideoats grama (Premier, 1960), 'Bell' rhodesgrass (Figure 1-3) (Bell, 1966), and 'TAM-GA S1A and TAM-GA S1B' sudangrass breeding lines (Craigmiles, 1969).

Figure 1-3. Bell rhodesgrass.

EXAMPLES OF IMPROVEMENT PROGRAMS

As indicated earlier, all important grasses are deficient in one or more traits and need improvement. However, improvement is neither practical nor possible with the large number of species of importance or potential importance in Texas. Improvement programs of varying intensities are being conducted. Examples will show the type of approaches being used and progress being made in the programs.

Buffelgrass

Buffelgrass is a drouth-tolerant, warm-season perennial bunchgrass native to the arid regions of South Africa and extending northward through India. It is the dominant grass of the Kaap Plateau, a 10- to 18-inch rainfall region in the Union of South Africa and is widespread throughout that country. Buffelgrass has survived in the Great Karoo, where average rainfall is only 5 to 8 inches, and it is a major forage grass in the Orange River region, where rainfall averages 6 to 13 inches.

Buffelgrass has been introduced into several countries and is one of the most important forage grasses in the warm, arid regions of Australia, Paraguay, Puerto Rico, Mexico, and Texas. At present, buffelgrass occupies more than 90 percent of the acreage recently seeded to grasses in Texas south of San Antonio. The major factors limiting extensive use of this grass are lack of cold tolerance and low survival on poorly drained soils. Obviously, improvement in these characteristics is the major objective in the buffelgrass breeding program.

Buffelgrass was first evaluated in Texas at the Angleton Substation in 1917 and later at Chillicothe (1918) and Tyler (1932). The results were negative, since these locations proved to be north of the area of adaptation or the soils were too heavy and too poorly drained for the then available buffel accessions. The first successful plantings of buffelgrass in Texas were made by the Soil Conservation Service in the nursery at San Antonio in 1946. Based upon this evaluation, SCS distributed two accessions in the late 1940's: T-4464 (a bunchgrass type called 'Common') and T-3782 (a rhizomatous type called 'Blue' buffel). Common eventually became the major variety for revegetation in South Texas below U.S. Highway 90 but lacked sufficient cold tolerance for use farther north. In fact, winter killing is experienced in parts of the southern region during some severe winters. The Blue variety was higher in forage yield and more cold tolerant because of its rhizomatous habit, but it never achieved major importance because of low seed production. Blue buffel production eventually was discontinued.

Buffelgrass is an extremely versatile species. In addition to having high drouth tolerance, it is well adapted to use under irrigation and is exceptionally high in digestibility. It is considerably more digestible and acceptable to livestock than Coastal bermudagrass and will produce more total forage than Coastal under irrigation in its area of adaptation. These characteristics justify maximum efforts to extend the range of adaptation of this valuable grass through breeding. Extending the northward range only 200 miles in Texas potentially would involve more than 50 million acres. Better adaptation to poorly drained and heavy soils would almost double this acreage in Texas. Elimination of the fluffy bristles surrounding the spikelets and development of varieties with compact spineless burs would be an

improvement of major economic importance in planting of this species and harvesting its seed.

Based upon the cytological and genetic data previously discussed, an extensive breeding program was initiated with buffelgrass. Higgins buffelgrass was the first variety developed in the program and released for use in South Texas. Higgins has increased vigor and rhizome development and the high seed production of Common. Initial objectives in the program were improvements in forage production, winter hardiness, seed production, and persistence under grazing . As the program developed improvement in forage nutritive quality (dry matter digestibility) and modification of the seed bur (involucre) were included as major objectives. Basic studies showed that birdwoodgrass, which has compact seed burs with short appendages, can be hybridized with sexual buffelgrass. Seed characteristics of birdwoodgrass are more favorable for mechanical planting and harvesting. Hybrids can be recovered with the vegetative vigor of buffel and with the seed bur characteristics of birdwoodgrass (Figure 1-4).

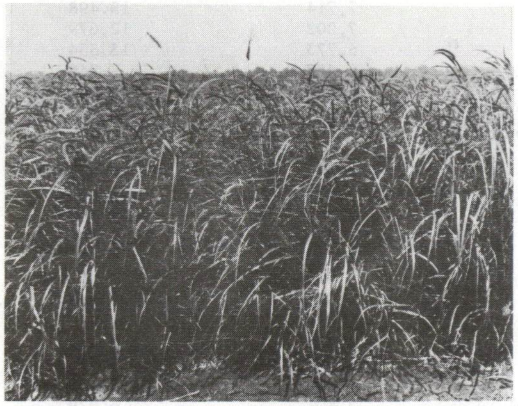

Figure 1-4. A buffel-birdwoodgrass hybrid with vigor of buffelgrass and seed characteristics of birdwoodgrass.

The protection afforded by rhizomes is the major factor responsible for cold tolerance in buffelgrass. Forage yield and rhizome development are closely correlated, since rhizomes promote rapid spread and a denser stand. Rhizomes also contribute to better persistence under heavy grazing and early spring growth. Thus, development of hybrids with strong, deep rhizomes is one of the most important objectives of the buffelgrass program.

Some of the new buffel hybrids, all of which are rhizomatous, have shown superior forage yield when compared with Common and Higgins in clipping trials (Tables 1-1, 1-2).

Table 1-1. Forage yield of buffel and buffel x birdwoodgrass hybrids, Texas A & M University Farm near College Station. Test established in 1968.

Strain	Yield/acre, Pound dry forage		
	1968[1)]	1969[2)]	1970[3)]
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
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
Buffel x Birdwoodgrass			
12	9,558	9,513	---
22	7,575	6,951	---
16	7,383	4,566	---
21	7,355	5,326	---
17	7,329	7,577	---
57	5,633	5,148	---
24	5,252	4,921	---
47	4,405	2,412	---
25	4,353	3,353	---
4	3,946	3,153	---
43	3,801	6,729	---

1)Harvested 7/9, 8/7, 9/20
2)Harvested 6/12, 7/14, 8/14, 9/15, 10/27
3)Harvested 6/29, 8/11, 11/9. Common, Higgins and all buffel x birdwood hybrids winter-killed in winter of 1969-70.

However, their superiority may not be apparent until the second and succeeding years when the influence of rhizomes is fully expressed (Tables 1-1, 1-2). The highest producing buffel hybrids exceeded Common and Higgins by 65 to 105 percent in the first

Table 1-2. Forage yield of buffel and buffel x birdwoodgrass bybrids, Texas A & M University Farm near College Station. Test established in 1970

Strain	Yield/acre, Pounds dry forage		
	1970[1]	1971[2]	1972[3]
Buffels			
331	10,340	12,370	12,719
18-35	9,889	11,421	12,736
2-1	10,334	10,893	11,861
1043	10,291	9,567	12,824
1-21	9,579	8,883	11,911
Higgins	9,586	8,479	8,414
Buffel x Birdwood			
88	8,061	8,552	8,749
69	7,118	6,673	6,161
12	8,426	5,796	7,111
101	9,549	5,251	7,118
91	9,069	1,326	5,517

1Harvested 7/20, 8/25, 11/12

2Harvested 6/11, 8/27, 9/30

3Harvested 5/23, 7/28, 10/3

test (Table 1-1) and 28 to 46 percent in the second test (Table 1-2). Buffel x birdwoodgrass hybrids, which have the advantage of a compact seed bur, are not as vigorous as the best buffel hybrids. However, the best of these hybrids produce as much or more forage than Common and Higgins buffel.

Two buffel hybrids (331 and 18-35) have improved cold tolerance. They survived three winters in North Texas (Table 1-3) but winter-killed the following winter. The most promising buffel x birdwoodgrass hybrids are adapted as far north as College Station but lack sufficient hardiness for more northern areas.

Table 1-3. Survival of buffelgrass and buffel x birdwood hybrids at Knox City and Stephenville, Texas. Tests established in 1971.

Strain	% survival - June 1972	
	Knox City	Stephenville
Buffels		
331	95	100
18-35	90	100
132	0	100
4-16	0	15
114	5	100
2-1	25	55
1043	85	100
KC 69-2	100	100
Common	0	0
Higgins	0	0
Buffel x birdwood hybrids		
88	40	45
37	85	80
154	45	60
101	0	0

Thus, experimental hybrids that yield significantly more than commercially available buffelgrass and that are adapted at least 150 miles north of Common and Higgins have been developed. However, the problems of seed production with rhizomatous, winter-hardy types and of winter hardiness in the buffel x birdwood hybrids have not been completely solved.

Kleingrass

Kleingrass (Panicum coloratum L.) is a warm-season perennial bunchgrass native to South Africa and also grown in Australia for forage and soil erosion control (Figure 1-5).

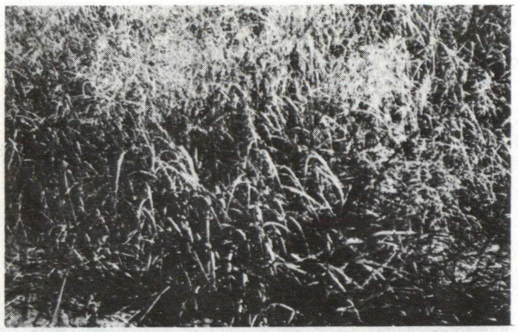

Figure 1-5. Kleingrass plant showing typical growth and high seed production.

Extensive studies have shown kleingrass to be adapted to a wide range of soils in Texas as well as to have the ability to withstand extended periods of hot, dry weather, to recover quickly from clipping, grazing or drouth, and to spread rapidly. Seed shattering is the major impediment to its more extensive use at present.

Kleingrass was first introduced in 1942, but useful types were not obtained until about 1952. Soil Conservation Service plantings in 1956 and 1957 demonstrated the adaptation of klein to a wide range of climatic, soil, and moisture conditions. However, seed production problems prevented any appreciable use of the grass until grazing studies in the mid-1960's demonstrated its superiority. Based on widespread interest, 'Kleingrass 75' was released jointly by the Texas Agricultural Experiment Station and the Soil Conservation Service in 1968 as representative of the best material available.

Basic studies with kleingrass (Hutchinson and Bashaw, 1963, 1964; and Burson and Bashaw, 1969) showed that the grass reproduces sexually with a chromosome number of 2N=36. While accessory chromosomes are present (Burson and Bashaw, 1969) and may confuse the picture cytologically, they seem to have no direct effect on the plant either in fertility or vegetative characteristics. Thus, they are not of major concern in improvement programs.

Kleingrass breeding has been concentrated on developing increased seed production ability, seed retention, and uniformity of growth habit (Figure 1-6).

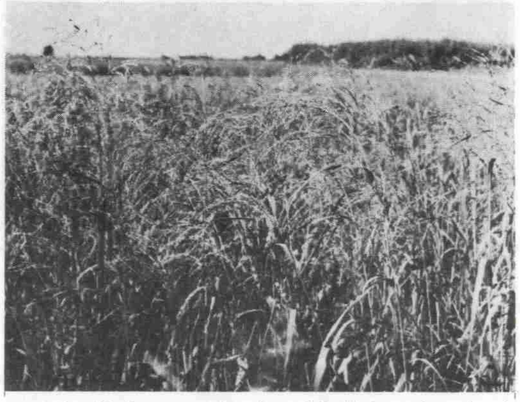

Figure 1-6. Kleingrass selection with high seed production.

Hearn and Holt (1969) did not find any differences in seed retention, but reported heritable differences in the important seed production components of fertile florets per panicle, seed per panicle, and percentage fertility. They also reported that plants selected for these characteristics and randomly crossed resulted in a 47 percent increase in harvested seed over unselected materials.

Seed production can be increased by selecting plants with increased numbers of seed heads and also large seed heads. A few plants have been identified with greater-than-average seed retention after maturity (Figure 1-7).

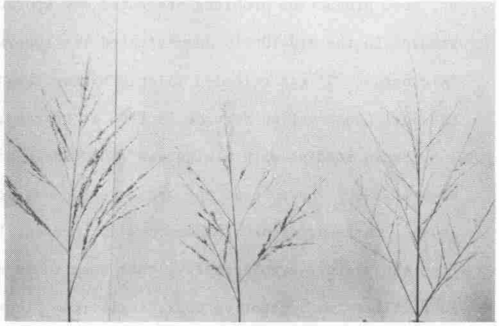

Figure 1-7. Kleingrass seed heads in equivalent stage of maturity showing seed retention (l) and seed shattering (r).

The florets are not attached tightly but are retained until all the florets on the inflorescence are mature and brown. A greater total volume of seed produced results in a greater amount of mature seed at any one time during flowering and seed maturation. Similarly, even a small degree of seed retention should result in more mature seed being available for harvest at one time. The best selections in these two categories have produced about the same amount of seed (Table 1-4).

Table 1-4. Characteristics and performance of kleingrass selections, Texas A & M University Farm near College Station, 3-year average.

Experimental selection	Basis of improvement	Seed production lb/acre	Forage production lb/acre
63-7	Seed head number and number	103	6,782
67-11	Seed Retention	95	5,742
64-5	Seed head number and size	86	5,569
67-9	Tall, robust	83	7,360
Kleingrass 75	---	74	5,104
67-8	Pubescent foliage	36	6,201
67-10	Glabrous foliage	27	6,120

Some individual plants have produced at the rate of over 160 pounds of seed per acre (Table 1-5). Thus, even further increases in seed production should be possible.

Selection pressure for increased number and size of inflorescences per plant may decrease plant height. The reduction may result from the limited gene base of a few plants highly selected for seed production or from the direct competition between vegetative and reproductive functions of the plant. The selections for seed production in the breeding program generally have produced as much or more forage than Kleingrass 75, though other selections in the program have been more productive (Table 1-4). The best seed-producing lines in the breeding program average from 10 to 30 percent more forage than Kleingrass 75 over a 3-year period.

Table 1-5. Seed production (pounds per acre) of kleingrass 67-11 progeny at a single harvest, Texas A & M University farm near College Station.

Parent clone	Number of progeny in each class Pounds seed/acre <40	40-80	80-120	120-160	> 160	Average Yield
1	3	2	4	4	1	102
2	2	2	2	8	1	128
3	5	6	2	2	6	56
4	3	3	1	1	2	101
5	1	2	5	5	2	140

Both the capacity and nutritive quality of kleingrass forage have been demonstrated (Chapter 12, Forage and Animal Production Programs for South Texas) in grazing studies at Beeville and McGregor. However, laboratory evaluations of dry-matter digestibility of individual plants have indicated that potential exists for further improvements in dry-matter digestibility (Table 1-6). While the value of these differences in kleingrass has not been demonstrated in grazing trials, other research has confirmed the significance of improved forage digestibility. Chapman et al. (1972) showed that Coastcross-1 bermudagrass forage, which exceeded Coastal bermudagrass by 12 percent in digestibility, produced animal gains under grazing which exceeded Coastal by 50 percent. At the higher levels of quality found in kleingrass, differences may not be as important as in bermudagrass, but if the differences observed among individual plants can be fixed in new selections, animal performance on kleingrass should be improved still further. Kleingrass 75 is available commercially and is a superior grass under many conditions. Prospects are excellent for the development of additional varieties with greater seed production, forage production, and forage quality.

Blue Panicgrass

Blue panicgrass (Panicum antidotale Retz.) is a tall bunchgrass adapted to light-textured soils west of the Blacklands from South Texas to the northern Panhandle. Blue panicgrass typically develops a dense mass of short, non-spreading rhizomes at

Table 1-6. In vitro digestibility of individual kleingrass plants from a selection for seed production, Texas A & M University farm, 1971[1].

Source	In vitro digestible dry matter (%) August 6	September 13	Average
120830	68.6	68.2	68.4
120901	65.5	64.3	64.9
120916	67.1	65.9	66.5
120501	64.4	56.5	60.4
120301	59.0	61.6	59.8
120302	67.8	69.6	68.7

1/ Selected plants showing the range in in vitro digestibility within a restricted source.

the base of the plant. The plants generally are robust with large stems which are succulent initially but become woody at maturity. Prior to maturity, forage is high in protein content and apparently of satisfactory digestibility, though some problems in palatability or acceptability to livestock have been reported by producers. Stands lose vigor (Chapter 3, Establishment, Management and Seed Production) after 1 or 2 years and become less productive than initially unless topdressed with high rates of nitrogen.

Variability in morphological characteristics such as stem size, plant height, plant density, and leafiness are apparent in spaced plant populations of blue panicgrass (Holt, 1963). Also, differences in vigor of individual plants in succeeding years following establishment have been observed.

Improvement in blue panicgrass has been limited to selection for smaller or finer stems and compact or dense plant growth (Figure 1-8) on the basis that these characteristics would make the plant more acceptable to grazing animals and at the same time provide some protection to the crown from close grazing. A dense crown would likely prevent the grazing animal from removing all basal leaves.

Three experimental selections (Table 1-7) are being tested for yield in clipping plots and for survival under grazing. The fine-stemmed type (63-5) has produced almost as much as the more robust types and slightly more than Common. The robust types (65-6 and 65-7) are higher in forage production than Common and equal or higher in seed production.

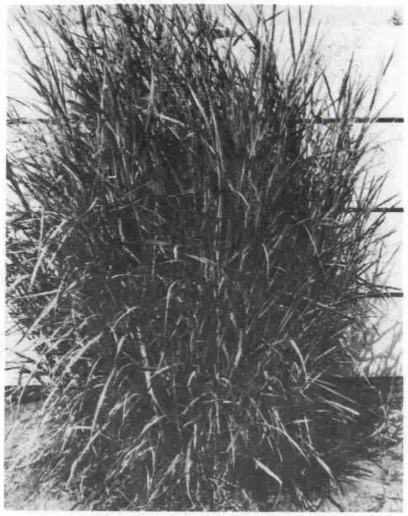

Figure 1-8. Blue panicgrass selection with fine stems and dense growth habit.

Dallisgrass

Dallisgrass (Paspalum dilatatum Poir.) is a warm-season perennial bunchgrass native to Central South America. Common dallisgrass is an excellent forage grass well adapted to the warm, humid regions of the world. The Common strain was introduced into the United States about 1875 and is found in perennial pastures from East Texas to the Atlantic Coast. Common dallisgrass (Figure 1-9) is a leafy, nutritious forage plant that grows well with other grasses and legumes, persists well under grazing, and has a long growing season. It develops and maintains good basal foliage even under grazing or clipping, which makes it tolerant to close grazing and also results in high-quality forage. Although it is an excellent forage grass, its use in improved pastures is limited because of poor seed quality and the difficulty encountered in establishing new stands. The percentage of seed-producing florets is extremely low, and seed material is often heavily infested with ergot. In spite of the seed problem, Common dallisgrass has been a valuable species in Texas rice-pasture programs, largely because of its ability to volunteer following the rice crop.

Dallisgrass is a predominantly apomictic species with very limited variation, and only a few different types have been discovered. Common is the only known strain of any value for pasture use. It is an obligate apomict, and its seeds develop without fertilization. Consequently, the strain is completely uniform and cannot be improved

Table 1-7. Forage and seed production of experimental lines of blue panicgrass, Texas A & M University farm near College Station.

Variety	Pounds dry forage/acre 1966	1967	1968	1969	Comparable average	Average pounds seed/acre 1/
63-5			3,676	5,886	5,704	96
65-6	6,200	8,515	3,496	6,433	6,161	119
65-7	6,270	8,700	4,283	5,967	6,305	86
Common	5,520	6,415	3,896	6,472	5,575	85

1/ Average production in 1968 and 1969.

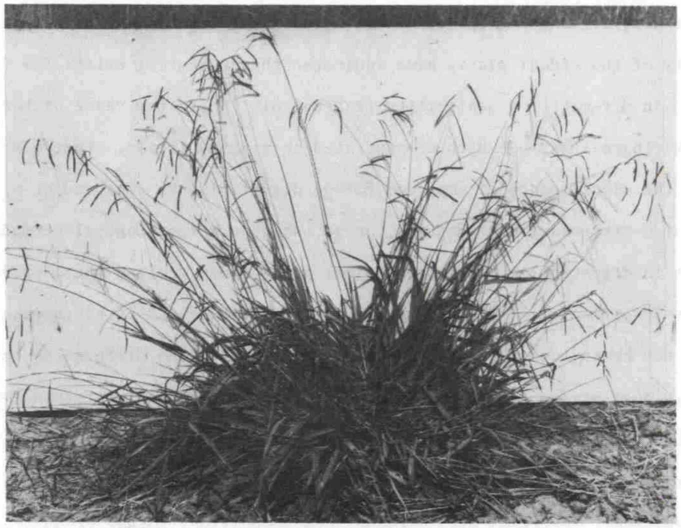

Figure 1-9. A typical dallisgrass plant with basal foliage.

by conventional breeding methods. (See page 1, Basic Studies). Efforts to develop new types in Common dallisgrass through the use of radiation and other mutagenic agents have not been successful.

Hope for improvement of dallisgrass in the future depends upon finding fertile apomictic types in the natural habitat or the discovery of sexual types for use in a breeding program. One highly fertile sexual dallisgrass type has been discovered, but it had no promise as forage or for breeding purposes. Unlike sexual buffelgrass, it was not cross-compatible with the apomictic strains. However, the presence of this strain suggests that other and perhaps useful sexual types exist in the native habitat of dallisgrass. In view of the potential promise of dallisgrass for improved pastures throughout the warm temperate regions of the world, an exploration of Central South America has been made and collections introduced for study and use in breeding programs.

Hybrid Bermudagrasses

Coastal bermudagrass (Chapter 6, Improved Grasses and Legumes) is the product of a grass improvement program in Georgia, but it is used extensively in Texas because trials and demonstrations showed its potential value. Coastcross-1 bermudagrass, also developed in Georgia, represents an improvement in nutritive quality, but lack of winter hardiness limits the area of adaptation to South Texas and Coastal areas. More recently, an extensive bermudagrass hybridization program in Oklahoma has produced hybrids which show promise of improved yield, adequate winter hardiness, and quality equivalent to Coastcross-1. Preliminary results with a few of these hybrids are shown in Table 1-8. These yields were produced under partial irrigation and with high nitrogen fertilization.

While complete information is not available on areas of adaptation, all of the new hybrids are more winter hardy than Coastcross-1, and most of them are equivalent to or more winter hardy than Coastal. Additional information on performance and areas of adaptation is being developed as rapidly as possible.

Table 1-8. Performance of bermudagrass hybrids, Texas A & M University Farm near College Station, 1972-75.

Hybrid	Rapidity of coverage	Rhizome development	Tons forage/ acre/year	% Forage digestibility	% protein
Coastal	Slow	Medium	8.9	60	11.0
Coastcross-1	Rapid	None	7.6	63	11.2
Alecia	Rapid	Medium	8.6	57	10.4
Oklan	Medium	Medium	7.5	61	--
S-16	Rapid	Limited	9.7	63	10.6
S-54	Rapid	None	8.9	62	10.2
S-66	Medium	Medium	10.1	60	11.4
SS-16	Slow	Medium	8.9	61	--

Other Species

Improvement programs have been and are being conducted with small grains for forage, annual ryegrass, hardinggrass, rhodesgrass, and persian clover. Evaluation of breeding materials from other programs, plant collections and plant introductions result in the release or increased use of improved varieties. Extensive evaluation programs have been and are being conducted with bermudagrass, sideoats grama, tropical legumes, and with several other species in cooperation with the Soil Conservation Service.

Evaluation of ryegrass plant introductions resulted in the release of Gulf ryegrass. Additional breeding and selection has increased the level of disease resistance in ryegrass. An expanded program at the Texas Agricultural Experiment Station at Overton includes improvement in seedling vigor and early forage production.

Wintergreen hardinggrass was developed from surviving plants of several plant introductions (Chapter 6, Improved Grasses and Legumes). Continuing work is directed toward increased cold hardiness in the seedling stage and increased summer dormancy to improve survival.

Work has been initiated on the improvement of tall fescue at the Texas Agricultural Experiment Station at Dallas. The primary objectives are improved adaptation to the environmental stresses of North Central Texas and improved forage quality.

SUMMARY

Coastal bermudagrass, which has been planted on more than 5 million acres in Texas, has shown the potential for improvement that exists in grass breeding. Coastal has almost unlimited production potential under optimum conditions of moisture, fertility, and light. It has the ability to respond rapidly to applied fertilizer and to irrigation or rainfall. At certain seasons, Coastal will not sustain a satisfactory rate of gain for younger animals because of limited nutritive quality. However, it has made significant contributions both to production programs and in showing the potential that exists through plant improvements.

Coastcross-1 bermudagrass is the first grass developed and released specifically for improved quality. Laboratory tests indicated that Coastcross-1 was 10 to 12 percent higher in digestibility and that animal performance should be improved 25 to 30 percent over that of animals consuming Coastal. Later grazing studies have shown an even greater improvement in animal performance than predicted.

These examples set the pace or serve as a basis for current improvement programs of TAES. Improved grasses must have the ability to survive or persist under unfavorable conditions but should respond rapidly to favorable conditions and should posses the quality necessary for favorable animal production. Considerable emphasis is placed on the quality aspect, since low quality is a major limiting factor in most warm-season grasses.

Grass and legume improvement programs have provided numerous improved varieties and breeding materials for still further improvements. Basic studies in reproduction methods have resulted in a major breakthrough in the use of apomixis in plant breeding. Through the hybridization of sexual and apomictic buffelgrass plants, true breeding F_1 hybrids have been developed. This procedure has wide application and implications in other grass improvement programs as well as in other crops.

Improved varieties of buffelgrass, hardinggrass, kleingrass, ryegrass, and rhodesgrass have been released. Progress in further improvement for specific characteristics of these species, as well as blue panicgrass, dallisgrass, and several other species, are being made. Both intensive breeding programs and evaluation of breeding materials from other programs may result in the identification and release of varieties. The latter approach is being used with some species either until the potential of the species is demonstrated or until adequate resources are available for a more intensive approach.

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