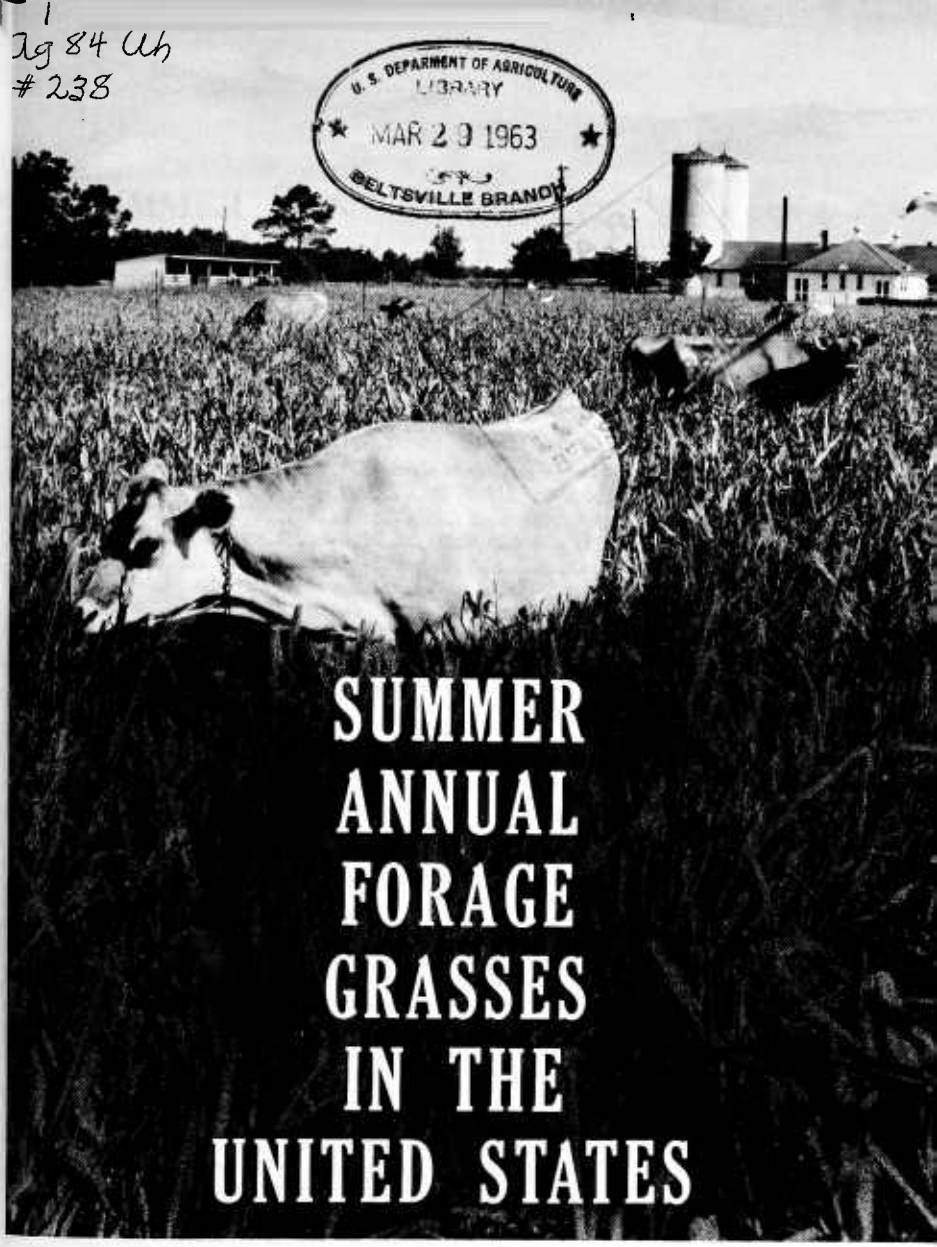

SUMMER ANNUAL FORAGE GRASSES IN THE UNITED STATES

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CONTENTS

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SUMMER ANNUAL FORAGE GRASSES IN THE UNITED STATES

A. A. HANSON, *research agronomist, Crops Research Division, Agricultural Research Service*

Summer annual grasses are used for supplementary pasture or emergency forages in most of the United States. In general, they are relied on to provide dependable supplies of high-quality forage in midsummer when perennial forage species are relatively low in yield or quality, or in both. There has been an increasing trend to consider these grasses an integral part of the total forage program rather than mere supplementary crops, which may or may not be planted, or emergency forage species to be seeded only when other crops have failed.

Summer annual grasses can be used as the sole source of pasture for part of the grazing season or can be used to supplement the diet of animals on permanent pasture. Dairy cattle on permanent pastures can be either fed green-chop or given access to annual pastures for 1 or 2 hours each day. In many Northern States, summer annuals furnish grazing from early July through September; while in the Southern States the grazing period normally starts in early June and continues to late August or, with late planting, good moisture supply, and warm temperatures, often to mid-October.

For year-round grazing in the South, it is frequently practical to rotate summer annual grasses with winter annuals, such as small grains or mixtures of small grain and ryegrass. Summer annuals are plowed under and winter annuals planted in September or early October.

There has been some interest in planting sudangrass and other summer annual grasses in permanent pastures in order to overcome the midsummer drop in yield and quality of perennial grasses. However, plant development in "sod seedings" is poorer than that obtained in well-prepared seedbeds because of excessive competition for moisture and nutrients. The relatively low yields of summer annual grasses in "sod seedings" probably accounts for the failure of the practice to become widespread.

Varieties of sudangrass, millets, johnsongrass hybrids, and sorghum × sudangrass hybrids are used as pasture only or as some combination of pasture, green-chop, hay, and silage. Forage sorghum and corn are valuable silage crops; they are not included in this handbook even though they are grown in certain areas for green-chop, dry fodder, and supplementary grazing.

Sorghum almum, which is a sorghum × johnsongrass hybrid and has some of the perennial characteristics of the johnsongrass parent, and perennial sweet sorgrass are included with the summer annuals because they are not strong perennials and in most areas have to be replanted every year.

COMPARATIVE YIELD AND FORAGE QUALITY OF SPECIES

Dependability, high yield, and forage quality are of first importance in choosing the best adapted species and variety for grazing, hay, or silage. Although most of the annual grasses produce dependable stands, they differ appreciably in forage yield and quality. The region and the management practices affect the various species differently.

Sudangrass is considered the standard summer annual for pastures, because of its wide adaptation and the large acreage grazed. Although sudangrass varieties differ in leafiness, coarseness, recovery after grazing, disease and insect resistance, and prussic acid levels, a number of general comparisons with other grasses may be made. Thus, the yield of sudangrass is inferior to that of improved varieties of pearl millet over most of the southeastern United States—from Maryland to east Texas and southward to and including Florida. The superiority of pearl millet is very marked in the southern part of this region (table 1). The difference in production between pearl millet and sudangrass is not so marked in the northern and western parts of the region (table 2).

TABLE 1.—*Average yield of sudangrass and pearl millet varieties at the Coastal Plain Experiment Station, Tifton, Ga., 1955–56* [1]

[Grown in rows 3 feet apart]

Variety	Dry-matter yield per acre at harvest on [2]—			Total
	July 1	July 29	Sept. 14	
Sudangrass:	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Common	443	1, 149	150	1, 742
Piper	732	1, 447	344	2, 523
Greenleaf	498	1, 110	214	1, 822
Sweet 372	542	1, 038	96	1, 676
Lahoma	369	1, 104	96	1, 569
Tift	606	1, 145	213	1, 964
Pearl millet:				
Common	2, 725	3, 029	1, 155	6, 909
Starr	2, 198	4, 017	1, 837	8, 052
Gahi-1	2, 802	4, 990	2, 946	10, 738

[1] Data furnished by G. W. Burton, Georgia Coastal Plain Experiment Station, Tifton, Ga.
[2] Average harvest date.

The superiority of pearl millet in the southern United States has been attributed to a combination of disease resistance, greater vigor, and better growth on deep sandy soils. In spite of these valuable characteristics, pearl millet has not attained much importance outside the Southeast. This situation may be explained in part by the following observations: (1) Although neither pearl millet nor sudan-

TABLE 2.—*Yield of Piper sudangrass and Gahi-1 pearl millet under various management treatments at the Tennessee Agricultural Experiment Station, Knoxville, Tenn., 1957* [1]

[Grown in rows 3 feet apart]

Cutting management		PIPER SUDANGRASS					
		Nitrogen, pounds per acre, applied at seeding—					
		0		60		120	
Height or maturity at cutting	Stubble height after cutting	Dry-matter yield	Cuttings	Dry-matter yield	Cuttings	Dry-matter yield	Cuttings
	Inches	*Pounds per acre*	*Number*	*Pounds per acre*	*Number*	*Pounds per acre*	*Number*
20 inches	6	2, 310	6	3, 080	6	3, 460	6
30 inches	6	2, 290	4	3, 250	5	3, 600	6
Do	10	2, 520	5	3, 540	6	4, 090	6
Early bloom	4	3, 240	3	4, 820	3	4, 820	3
		GAHI-1 PEARL MILLET					
20 inches	6	3, 670	6	4, 760	6	5, 390	6
30 inches	6	3, 790	5	3, 920	6	5, 550	6
Do	10	5, 190	5	5, 200	6	6, 240	6
Early bloom	4	4, 800	3	6, 140	3	7, 250	3

[1] Adapted from K. R. Broyles and H. A. Fribourg, Agron. Jour. 51 : 277–279. 1959.

grass thrive at low temperatures, sudangrass has a somewhat greater tolerance to low temperatures. (2) Sudangrass recovers better than pearl millet when subjected to very close grazing or clipping, and this difference appears to be accentuated when moisture is limited. (3) Sudangrass appears to be better adapted than pearl millet for use in areas where moisture supplies are very limited. (4) Sudangrass is somewhat less susceptible to chinch bug damage.

Millet species, other than pearl millet, are decidedly inferior to sudangrass for hay and pasture. However, limited acreages of several millet species are planted either as catch crops or because environmental conditions are not well suited for sudangrass.

Adapted sudangrass varieties have a much higher tolerance to frequent grazing or clipping than *Sorghum almum*; consequently, under intensive management they surpass *Sorghum almum* in forage production (table 3). However, the yield of *Sorghum almum* may equal or exceed that of sudangrass when compared either on the basis of silage or silage plus aftermath.

TABLE 3.—*Average yield and height of sudangrass varieties and hybrids and Sorghum almum at the Nebraska Agricultural Experiment Station, Lincoln, Nebr., 1959–60* [1]

[Grown in rows 1 foot apart]

Variety or hybrid	Dry-matter yield per acre						Average height at harvest on [2]—				
	At harvest on [2]—					Total					
	July 8	July 25	Aug. 13	Sept. 1	Oct. 15		July 8	July 25	Aug. 13	Sept. 1	Oct. 15
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
Piper	1, 413	1, 695	1, 297	1, 077	1, 254	6, 736	31	31	28	28	28
Wheeler	1, 621	2, 132	1, 634	1, 265	1, 554	8, 206	31	34	29	28	30
Sweet 372	1, 232	1, 330	922	712	708	4, 904	23	26	22	20	22
Perennial sweet sorgrass	530	943	698	745	325	3, 241	20	24	19	19	16
Sorghum almum	878	1, 432	854	1, 128	935	5, 227	23	26	18	23	17
Commercial sorghum × sudangrass hybrid	1, 629	1, 371	1, 262	1, 099	641	6, 002	29	28	28	29	24

[1] Data furnished by L. V. Peters, Nebraska Agricultural Experiment Station, Lincoln, Nebr.
[2] Average harvest date.

High yield potential is a characteristic feature of most commercially available sorghum × sudangrass hybrids. Maximum yield is obtained when these hybrids are harvested either at or near maturity or for silage and aftermath. Although recovery is good, total production under intensive grazing or frequent clipping is, in general, not superior to that obtained from adapted sudangrass varieties (table 3 and 4). These hybrids produce more silage than *Sorghum almum;* hence, the selection of these for silage should be seriously considered in areas where moisture supply restricts production to a single harvest.

Comparison of annual forage grasses on the basis of forage quality is similar to that for forage yield. In general, with adapted species, those that are tolerant to grazing or harvesting at frequent intervals give higher quality forage as measured by animal performance and chemical composition. This is true because the chemical composition of the young grass is better suited to the needs of the animals. Thus, the crude protein content of common sudangrass may exceed 20 percent when the first growth reaches the pasture stage, but it may fall to 8 percent or less at full bloom. In addition, young grass is palatable and succulent and is consumed in the large quantities needed for the efficient production of milk and meat.

The good recovery and high percentage of leaves produced by properly managed sudangrass and pearl millet would seem to give these species a decided advantage over sorghum × sudangrass hybrids and *Sorghum almum* in the production of high-quality forage. Grazing studies in which sudangrass proved superior to *Sorghum almum* in both forage quality and carrying capacity confirm this observation. Comparative grazing data are lacking for the newer sorghum × sudangrass hybrids, but clipping results suggest that many hybrids are inferior to the better sudangrasses in forage quality.

However, harvests made either at heading or full bloom favor pearl millet, sorghum × sudangrass hybrids, and *Sorghum almum* where these species are adapted. As a rule, these species are more resistant than sudangrass to certain leaf diseases that reduce both forage quality and yield.

Improved sudangrass and pearl millet varieties are very similar in forage quality, as measured by the performance of livestock grazing well-managed pastures. Thus, the selection of sudangrass or pearl millet for pasture purposes can apparently be based on their relative yield potential in a given area.

TABLE 4.—*Average yield and height of Wheeler and Piper sudangrass and a commercial sorghum × sudangrass hybrid at the Fort Hays Branch Station, Hays, Kans., 1961* [1]

[Grown in rows 1 foot apart on land summer-fallowed the previous year [2]]

Variety or hybrid	Dry-matter yield per acre					Height at harvest on—			
	At harvest on—				Total				
	July 10	July 31	Aug. 25	Oct. 4		July 10	July 31	Aug. 25	Oct. 4
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Inches*	*Inches*	*Inches*	*Inches*
Wheeler	1, 740	2, 540	3, 120	2, 220	9, 620	37	39	47	27
Piper	1, 320	2, 500	3, 320	1, 940	9, 080	34	35	45	24
Commercial sorghum × sudangrass hybrid	1, 380	2, 480	2, 940	1, 240	8, 040	34	33	47	19

[1] Data furnished by H. L. Hackerott, Fort Hays Branch Station, Hays, Kans.
[2] Rainfall was above average in 1961.

PRUSSIC ACID POISONING

Young plants and leaves of sorghum, sudangrass, and johnsongrass contain the glucoside durrin, which breaks down to release a poison known as prussic acid, or hydrocyanic acid (HCN). Caution must be exercised in grazing plants that contain appreciable quantities of this poisonous substance.

Sorghum is much higher than sudangrass in prussic acid, and, in general, it is unsafe for pasturing except after plants reach maturity and no new growth is present. Sorghum silage may contain toxic quantities of prussic acid, but it escapes in gaseous form when the silage is moved and fed. Under most circumstances, silage and well-cured fodder can be fed with safety. Prussic acid is released very quickly from the glucoside form in frozen leaves, and hence frosted sorghum is very dangerous until it begins to dry out.

Usually there is little danger of prussic acid poisoning in grazing most varieties of sudangrass. However, the young growth that follows clipping, drought, frost, or grazing may contain appreciable quantities of prussic acid. The following precautions are recommended: (1) Use pure seed that is not contaminated with sorghum; (2) select varieties that are low in prussic acid; and (3) let animals graze only when the plants have reached a height of 18 inches (sudangrass at this height contains a very small percentage of the rapidly growing tissue that is normally high in prussic acid).

Prussic acid poisoning is more liable to be a problem in the Northern States than in the Southern States. The periods of low temperatures common in the Northern States cause slow growth rates with a large percentage of young tissue, which is high in prussic acid.

SUDANGRASS

Sudangrass (*Sorghum sudanense* (Piper) Stapf) was brought to the United States in 1909 from a seed collection made near Khartoum in the Sudan. It was planted first at Chillicothe, Tex., and subsequently distributed to many experiment stations. Sudangrass soon became the most important temporary pasture plant in the country—a position that it has maintained.

Sudangrass is a freely tillering annual bunchgrass that grows to a height of 4 to 5 feet in broadcast plantings and 6 to 8 feet in cultivated rows. The stems are about $\frac{3}{16}$ to $\frac{1}{4}$ inch in diameter; the blades are approximately 1 inch wide. The typical loose panicle is about 18 inches in length. Seeds of most varieties remain enclosed in the glumes after threshing. Several leaf diseases attack sudangrass; these reduce the yield and quality of plants grown for silage, hay, and seed. However, many of these diseases are of little consequence when growth is rapid and the forage is grazed. Development of disease-resistant varieties is the most effective method of control.

Sudangrass will grow on a wide range of soil types, but it does not make satisfactory growth on cold, wet soils. Yields are low on sandy

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soils unless moisture conditions are favorable and the crop is supplied with adequate fertilizer. Sudangrass does best on good loam soils. In general, a complete fertilizer should be applied at planting. It is advisable to supply a total of 50 to 100 pounds of nitrogen per acre; the amount needed depends on the initial level of soil fertility. Half the nitrogen should be added in midsummer to encourage regrowth.

Sudangrass requires warm-to-hot weather for good growth. It should not be planted until the soil becomes warm, which may be 1 to 3 weeks after corn-planting time. In humid regions, good-quality sudangrass seed is drilled or broadcast at 20 to 25 pounds per acre; in dry areas, 12 to 15 pounds per acre is usual. Forage plantings are sometimes made in rows 24 to 36 inches apart if moisture is limited or cultivation is required to reduce weed competition. Seed-production fields are planted in rows 36 to 42 inches apart at 5 pounds of seed per acre or less.

Although sudangrass is palatable and readily eaten at the early-heading stage, recovery is improved if plants are grazed at an earlier stage of growth. However, pasturing should be delayed until the stand reaches a height of 18 to 24 inches. Sudangrass pastures should be divided into fields of such size that they can be grazed down quickly. Under rotational grazing, the carrying capacity for short periods may exceed six animals per acre. Grazing when the regrowth reaches a height of 24 inches helps to maintain the supply of young, succulent, and highly nutritious forage.

The feeding value of good-quality sudangrass hay, harvested at early heading, is about equal to that of timothy and johnsongrass. In humid areas, hay quality may be reduced by leaf diseases and curing problems; thus, it may be desirable to make excess forage into silage. Sweet varieties are easier to preserve and make better silage than nonsweet strains. In some areas, 30 to 60 pounds of soybeans per acre are drilled with sudangrass to improve silage quality.

Varieties

Sudangrass varieties differ in several important respects, including prussic acid potential, sweetness of stem, and amount of regrowth after grazing or clipping (fig. 1). Recovery differences among sudangrass varieties are shown in tables 3 and 4, but these data are not representative of varietal performance in all environments. Most other commercially available varieties are two to three times higher than Piper in prussic acid content. However, there is very little likelihood of poisoning, provided reasonable precautions are taken, in grazing these varieties. Sweet varieties, such as Sweet 372 and Lahoma, have sweet, juicy stems and can be distinguished by the cloudy appearance of the leaf midrib. Sweet varieties are very palatable and, for this reason, are preferred by some farmers to the dry, pithy-stemmed nonsweet types. Improved varieties of common sudangrass are higher yielding than sweet sudangrass; in many trials they have produced substantially more forage and more livestock products per acre.

Named sudangrass varieties were developed in different parts of the country, and for the most part they were selected for specific traits. A knowledge of their important characters is essential to understanding the conditions under which they perform best. Certi-

fied seed of the varieties described in this handbook can be purchased in those regions where the varieties are adapted.

FIGURE 1.—Plots of sudangrass varieties about 3 weeks after the grass had been clipped, at Lincoln, Nebr. Clipped on July 27; photographed on August 15. (Courtesy of the Nebraska Agricultural Experiment Station.)

California 23.—California 23 was selected from common sudangrass at the California Agricultural Experiment Station. It is vigorous and productive under California conditions but not outstanding at other locations. This variety is very susceptible to leaf diseases when grown in humid regions.

Greenleaf.—Greenleaf was selected at the Kansas Agricultural Experiment Station from a cross between common sudangrass and Leoti Red sorghum made at Chillicothe, Tex. Greenleaf is a vigorous variety that is variable for the sweet character. It has some resistance to foliage diseases and is adapted over much of the southern Great Plains and the eastern United States.

Lahoma.—Lahoma is a sweet variety selected at the Oklahoma Agricultural Experiment Station. It is late maturing and possesses distinctive broad, yellow-green leaves. Leaf diseases may be troublesome when moisture is excessive. Lahoma has not been outstanding in most comparative yield trials.

Piper.—Piper was developed at the Wisconsin Agricultural Experiment Station, from the Tift variety and lines received from the Texas and Kansas Agricultural Experiment Stations. Piper was selected for its low prussic acid content. It has some resistance to leaf diseases at northern locations. It is the only sudangrass variety recommended for use in several Northern States. Piper is widely used throughout the United States because of its low prussic acid content and its excellent recovery after grazing or mowing.

Sweet 372 (Texas SA 372).—Sweet 372 is the original sweet variety developed at Chillicothe, Tex., by crossing common sudangrass and Leoti Red sorghum. It is similar to common sudangrass except for its sienna-colored glumes and sweet, juicy stems. Sweet 372 is resistant to bacterial blights, but susceptible to several other leaf diseases and

is lower yielding than improved nonsweet types. Sweet (S–1), a selection made within Sweet 372, is fairly similar in performance to the original variety.

Tift.—Tift was developed cooperatively by the Agricultural Research Service, U.S. Department of Agriculture, and the Georgia Agricultural Experiment Station. Tift is a late-maturing, leafy, fine-stemmed variety that is resistant to many of the leaf diseases found in the Southeastern States. Tift is very productive, but it has failed to attract very much attention—probably because improved pearl millet varieties are more productive in the region for which Tift was developed originally.

Wheeler.—Wheeler is an early-maturing variety selected out of common sudangrass by Carl Wheeler of Bridgeport, Kans. Wheeler is vigorous and tillers freely, but it is very susceptible to disease. Wheeler is the first named variety of sudangrass developed in the United States. Its continuing popularity in parts of the central Great Plains can be attributed to its excellent regrowth after grazing (table 3).

PEARL MILLET

Pearl millet (*Pennisetum typhoides* (Burm.) Stapf & C. E. Hubb.)[1] is used almost exclusively for forage in the United States. Pearl millet became established as a minor pasture crop in the Southeastern and Gulf Coast States following its introduction during the mid-1800's. It has increased in popularity with the release of the improved variety, Starr, in 1951, and there is every indication that this trend will continue in the Southeastern States. Pearl millet has been called Penicillaria, Pencilaria, Mand's Forage Plant, and cattail millet.

Pearl millet is an annual that grows to a height of 10 feet or more and produces many tillers. Stems range from 3/8 inch in diameter at the base with high planting rate to 1 inch with low planting rate. The heads are about 1 inch thick and 8 to 24 inches or more in length; the "pearllike" seed, which thresh free from the hulls, are larger than those of other millets. Pearl millet maintained in the vegetative condition remains relatively free from disease. Leaf diseases cause some damage on mature plants, and young millet plantings may be seriously damaged by armyworms and the lesser cornstalk borer. Pearl millet is free of the prussic acid glucoside that is found in sudangrass and other sorghums.

Pearl millet is used primarily for pasture, but it is also a valuable silage crop. In the humid Southeastern States, pearl millet produces higher silage yields than either sorghum × sudangrass hybrids or *Sorghum almum*. It can be made into hay, but curing is difficult throughout most of the humid area because of the high moisture content of the fodder.

Pearl millet will grow on sandy soils. However, a complete fertilizer at planting and topdressing with nitrogen during the growing season improve yields on most soils. Where rainfall is adequate, 100 to 150 pounds of nitrogen give a profitable return on a wide range of soil types.

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[1] This species has been incorrectly known as *Pennisetum glaucum* (L.) R. Br.

Good-quality pearl millet seed is seeded at 10 pounds per acre in rows 24 to 36 inches apart and at 25 pounds per acre in close-drilled rows. Much of the seed produced in the Southeastern States is low in quality; hence, heavier planting rates should be used for locally grown seed. Highest forage yields have been obtained from drilled plantings that have been supplied with adequate nitrogen. Since row plantings permit cultivation, they are preferred on weedy soils.

Proper management of pearl millet pastures varies with number of livestock, acreage available, and growth rate of the millet. However, under all circumstances, the millet acreage should be divided into individual pastures, each planted on a different date, and rotational grazing should be practiced. These practices extend the grazing season and provide good-quality forage. Pastures that cannot be grazed at the correct stage of growth should be harvested for silage.

When the millet provides only part of the forage requirements of the livestock, the available forage is best utilized by stocking at a sufficiently heavy rate so that most of the herbage in an individual pasture is grazed within a few days. Additional control of stocking rate can be obtained by the use of an electric fence to divide pastures into smaller units. Individual pastures should be grazed when the millet is 24 to 30 inches high and the ungrazed plants and stubble clipped to a height of 8 to 10 inches when the animals are moved to another pasture. Mowing encourages the development of leafy, high-quality aftermath. Livestock should be given access to the high-quality pearl millet for a short period each day, with the rest of their forage requirements met from permanent pastures.

When pearl millet provides all or nearly all the pasture needs for most of the growing season, there may be considerable difficulty in maintaining the larger acreage of pearl millet pasture at the proper grazing height. Grazing should start as soon as the plants reach a height of 15 inches and continue until most of the leaves are grazed off. The cattle may have to be moved before the first pasture is grazed completely for, insofar as possible, the second pasture should be grazed before the millet reaches a height of 24 inches. Pastures should be mowed to an 8- to 10-inch height when the accumulated stubble is about 30 inches high. Animals should never be forced to graze the stemmy material that accumulates on these pastures. Regrowth after mowing is ready to graze when it is 18 to 24 inches tall.

Pearl millet should be harvested for green-chop when it reaches a 30-inch height and for silage when the first heads appear. A stubble height of 6 to 10 inches is suggested when fields are cut for green-chop or silage. Silage should be chopped fine, mixed thoroughly with a preservative (such as ground corn at 100 to 150 pounds per ton), and packed in an airtight silo. Plastic covers keep air out and help to reduce spoilage.

Varieties

Starr and Gahi-1 are the two most important pearl millet varieties in the United States and the only ones for which adequate seed supplies are available. They were both developed at the Georgia Coastal Plain Experiment Station, Tifton, Ga., by the Agricultural Research Service of the U.S. Department of Agriculture and the Georgia Agricultural Experiment Station. The excellent performance of Gahi-1

and Starr in southern Georgia is shown in table 1. Gahi-1 is higher yielding than common pearl millet over its entire range of adaptation; while, at many locations in the Southeastern States, Starr and common do not differ appreciably in total dry-matter production.

Starr.—Starr has broader leaves and shorter internodes and stems than common pearl millet. Although these two types are often comparable in total dry-matter production, Starr is much leafier. Starr is easier to manage, lasts longer, and produces more beef and milk under grazing than common pearl millet; as a result, dairymen have a high regard for this variety.

Gahi-1.—Gahi-1 is a hybrid variety, produced by harvesting open-pollinated seed from isolated plantings of four inbred lines. Seed should not be harvested from Gahi-1 plantings, as vigor declines sharply in the second generation. This variety is very vigorous and produces good forage yields in some marginal areas where Starr and common pearl millet are very poorly adapted. It is leafier, later maturing, and recovers faster after grazing than the common type. Gahi-1 appears to be comparable with Starr in forage quality, and it can be recommended for maximum forage yields. Because of its rapid growth and recovery, Gahi-1 is more difficult to manage properly than the lower yielding Starr.

SUDANGRASS HYBRIDS

Farm experience indicates that sudangrass hybrids can be used very effectively for silage and, by taking proper precautions to avoid prussic acid poisoning, for grazing. Little information is available on the management of hybrid varieties.

Sorghum* × *sudangrass.—Commercial seed companies have marketed seed of closed-pedigree sorghum × sudangrass hybrids since about 1959. These F_1 hybrids were developed by crossing cytoplasmic male-sterile sorghum lines with improved varieties of sudangrass. These hybrids are leafier and tiller more than typical forage sorghums; they vary in yield, prussic acid potential, and growth habit with the particular male-sterile sorghum and sudangrass pollinator selected for crossing.

In general, these hybrids have equaled or surpassed some open-pollinated forage sorghums when harvested for silage, but, as previously mentioned, they are not superior to adapted sudangrass varieties in yield when clipped frequently to simulate rotational grazing (tables 3 and 4). It is possible that the forage quality of some, if not all, sorghum × sudangrass hybrids will prove to be below that of improved sudangrass and pearl millet varieties. The hybrids are resistant to many leaf diseases, but those that have been tested have had three to seven times more prussic acid than Piper sudangrass.

Suhi-1.—Suhi-1 was developed at the Georgia Agricultural Experiment Station, Experiment, Ga., by pollinating male-sterile Rhodesian sudangrass (*Sorghum arundinaceum* Stapf) with Tift sudangrass. Suhi-1 is above average in leafiness and has a high yield potential in some environments. It has surpassed standard sudangrass varieties in total yield and recovery in the Southeastern States, but its recovery has been inferior to that of adapted sudangrass varieties in some Midwestern and Great Plains States. Suhi-1 is comparable with

Sorghum almum in prussic acid content; it has 6 to 11 times more prussic acid than Piper sudangrass. **Extreme caution should be exercised in grazing this variety, especially in northern latitudes.**

SORGHUM ALMUM

Sorghum almum has a fascinating history. Seed was collected first in 1936 by an agronomist in the Province of Sante Fe in Argentina. This collection was studied in 1943 by the botanist Lorenzo Parodi, who named the grass *Sorghum almum* Parodi. He concluded that it must have originated under cultivation as a hybrid between sorghum and johnsongrass (*Sorghum halepense* (L.) Pers.).

By the time Parodi described *Sorghum almum* in 1943, it was being grown on a limited commercial scale in Argentina. In the mid-1940's seed was distributed from Argentina to research workers in the United States, Australia, South Africa, and England. The only sizable increase in the United States directly attributable to these early introductions was made by the Soil Conservation Service in California; but this increase work was discontinued because of concern over the possibility that the species might become a serious weed.

Another introduction of *Sorghum almum* was brought to the United States from South Africa in about 1952. This accession, known by the South African name "columbusgrass," is thought by some workers to be superior to other strains of *Sorghum almum*. *Sorghum almum* seed has also been marketed under the name "sorghum grass."

At present, the major source of *Sorghum almum* in the United States traces to a small seed lot received in the early 1950's by a rancher in western Texas. This seed lot was sent to him by a friend in New Zealand; hence, the name "New Zealand" *Sorghum almum*.

Sorghum almum is a weak perennial that persists reasonably well where winters are mild, but it is subject to severe winterkilling in most Northern States. It has failed to survive under intensive grazing in parts of northern Texas, and it has not overwintered satisfactorily in Oklahoma. *Sorghum almum* has very short, thick rhizomes that turn up close to the crown. But where *Sorghum almum* is adapted no difficulty has been experienced in killing the plants by plowing.

The seed shatters readily, and shattering may cause a serious weed problem in irrigated areas where seed could be distributed through irrigation water. In general, volunteer seedlings are very thick in seed fields. Productivity of these fields can be maintained, in part, by applying fertilizer and by cultivating to destroy seedlings growing between the original rows.

No one has been too concerned about the control of typical *Sorghum almum* on cropland; however, research workers have been concerned, and rightly so, with the danger of introducing johnsongrass or hybrids between johnsongrass and *Sorghum almum*. *Sorghum almum* seed is somewhat larger than johnsongrass seed, but otherwise they are indistinguishable. Seed size in these two species overlap, and it is virtually impossible to certify that no johnsongrass seed is in any particular seed lot. Johnsongrass is widespread in the seed-producing areas of New Mexico and Texas; and it is very difficult to insure against occasional outcrossing with johnsongrass. The lack of dis-

tinguishing seed characteristics has been one of the principal reasons why *Sorghum almum* has been classed as a noxious weed in several States.

Sorghum almum is a robust species that looks very much like a large version of johnsongrass. First-year stands make a very fine appearance, especially when grown to maturity. *Sorghum almum* is relatively late in maturing and remains green and continues to grow longer than either common or Piper sudangrass. Thus, mature stands of *Sorghum almum* may look more impressive than early-maturing sudangrass varieties.

Yield data collected at several locations indicate that *Sorghum almum* is not so outstanding as appearances might lead one to expect. *Sorghum almum* has not outyielded adapted sudangrass varieties; in fact, it has actually produced as much as one-quarter to one-half ton less dry matter per acre when seeded in rows 1 foot apart and clipped to simulate grazing.

The highest yields of *Sorghum almum* have been obtained from rows spaced 3 feet apart and seeded at 3 to 5 pounds per acre. Yields of 2 to 4 tons of dry matter per acre have been reported from this type of seeding in Texas. It seems fair to conclude that *Sorghum almum* has a reasonably good yield potential; but, when it is managed to obtain high yields, forage quality is inferior to that of improved sudangrasses.

Sorghum almum is somewhat better adapted than the sudangrasses for living through protracted dry periods and recovering with fall rains. The sudangrasses, however, appear to be better adapted for taking advantage of limited rainfall received at the beginning of the growing season or for capitalizing on moisture reserves in the soil. This explanation might account for those dryland tests in which the sudangrasses have produced more forage than *Sorghum almum*. As mentioned previously, *Sorghum almum* is high in prussic acid and must be grazed with caution.

PERENNIAL SWEET SORGRASS

Perennial sweet sorgrass was released by the Texas Agricultural Experiment Station in 1957. It was developed from a cross between common sudangrass and johnsongrass (*Sorghum halepense* (L.) Pers.) made at Cornell University. The hybrid seed was crossed with sweet sudangrass in Texas and selected for its sweet juicy stalks, good fertility, and a perennial root growth habit intermediate between johnsongrass and sudangrass. The seed, which is not subject to shattering, is similar to that of sweet sudangrass in size, shape, and color.

Perennial sweet sorgrass has short, thick rootstalks, but it has not persisted so well as *Sorghum almum*. The Texas station recommends reseeding it every year in most areas. It is considered to be superior to *Sorghum almum* in quality, but in many areas it has been less productive than *Sorghum almum* and adapted varieties of sudangrass (table 3). Recommended seeding rates are 4 to 5 pounds per acre in wide-spaced rows or 15 to 20 pounds in close-drilled or broadcast plantings.

FOXTAIL MILLET

Foxtail millet (*Setaria italica* (L.) Beauv.) has been used almost exclusively in the United States for emergency hay production. It is used to a lesser extent for grain, birdseed, silage, and pasture. Foxtail millet grows best under warm conditions, and it is well adapted for use as a late-planted hay crop.

The foxtail millets have erect, mostly simple but sometimes branching stems that grow to a height of 2½ to 5 feet under cultivation. The seeds are borne on a rather dense, cylindrical spike. Lobed heads distinguish the German variety from other varieties of foxtail millet. Several varieties are recognized; the better known are common, German, Hungarian, Siberian, and Kursk. German and common are the ones most generally grown.

Foxtail millet seed is planted with a grain drill at about 10 to 15 pounds per acre in dry areas, and at 25 to 30 pounds per acre where moisture conditions are favorable. The normal growing period for common foxtail is 70 days, and that for the German variety is 85 days. Under favorable conditions early varieties can be harvested for hay within 50 days after planting. Foxtail millet produces good yields of hay on fertile soils, but it is not suited for pasture because the shallow-rooted plants are easily destroyed by grazing and recovery is poor.

Foxtail millet has declined in importance since the introduction of sudangrass and the development of early-maturing varieties of sorghum and corn. The reduction in acreage and value can be attributed also to increasing mechanization, which greatly speeds up replanting operations. Under most conditions, sudangrass and early-maturing forage sorghums are more suitable than foxtail millet even when used as late-seeded catch crops.

JAPANESE MILLET

Japanese, or barnyard, millet (*Echinochloa crusgalli* var. *frumentacea* (Roxb.) W. F. Wight) is coarser than foxtail millet. It makes much better growth under cool growing conditions than either foxtail millet or sudangrass. It is used to a limited extent in the Northeastern States as a source of cut green feed for dairy herds. Japanese millet seed is ordinarily drilled or broadcast at 25 to 30 pounds per acre.

BROWNTOP MILLET

Browntop millet (*Panicum ramosum* L.) is a minor forage plant in parts of north-central Georgia and adjacent areas. It is a fine-stemmed plant that grows 2 to 4 feet tall and produces good-quality hay and pasture. However, it has a relatively short season of growth and produces much lower forage yields than sudangrass or pearl millet. The seed shatters readily, and volunteer stands following crimson clover are sometimes used for forage. It is planted at 8 pounds per acre in rows 2 feet apart or at 10 to 12 pounds in broadcast seedings.

Browntop millet, because of its high seed yields and natural reseeding characteristic, is included in wildlife plantings made to encourage game birds.

SEED PRODUCTION

Summer annual grasses are grown for seed in the central and southern Great Plains and under irrigation in the Southwestern States. California, Texas, and Colorado are the leading sudangrass-producing States—both in acreage and in total production of clean seed. Average yield per acre in these States range from about 1,600 pounds in California to 300 pounds in Colorado; the average yield per acre for the entire country was 614 pounds in 1960. Seed production of some other summer annuals is concentrated in the following States: Pearl millet in Texas, Arizona, and New Mexico; German millet in Texas and New Mexico; *Sorghum almum* in Texas and New Mexico; and perennial sweet sorgrass in Texas. Pearl millet produces 1,500 pounds of seed per acre, or more, under irrigation but only around 500 pounds per acre in nonirrigated fields. *Sorghum almum* seed yields range from 300 to 1,500 pounds per acre. Under favorable conditions 1,000 pounds of foxtail millet seed per acre is not unusual.

All the summer annuals may be combined directly, but with sudangrass this practice leads to heavy seed losses because of uneven ripening and excessive shattering. Windrowing sudangrass-seed crops and combining from the windrow is a widespread practice in the major seed-producing States. However, considerable acreages of sudangrass are harvested by cutting with a binder when most of the seed is in the hard-dough stage, placing the bundles in shocks, and threshing from the shock with a combine. Pearl millet and German millet are combined either directly or from the windrow. The best yields of *Sorghum almum* have been obtained by cutting with a binder when the first seeds are ready to shatter, shocking the bundles, and threshing from the shock.

Seed of the summer annuals is usually harvested from the first crop, although it is possible to harvest seed from a second crop of sudangrass and pearl millet under the long-season irrigated conditions of the Southwest. Under these circumstances, the first crop is grazed or cut early for silage and the regrowth saved for seed.

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