11 - Grain Sorghum for Forage

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Bermudagrass is the most important warm-season perennial grass in the South, but many other grasses play an important role in a complete forage system. Annual forages such as pearl millet, sorghum-sudangrass hybrids, forage sorghums and grain sorghums can be used to supplement bermudagrass or other warm-season perennial grasses. Summer-annual forages are often planted to provide supplemental grazing, hay or silage for livestock. This is especially important for those classes of livestock that require higher nutrient densities in order to maintain acceptable weight gains or milk production.

Additionally, the establishment of these forages in the late spring may allow producers to provide periods of rest for perennial cool-season pastures, such as tall fescue or mixtures of tall fescue and legumes. By resting cool-season perennial pastures in July and August, these stands are more persistent and supply more fall grazing. Much of the land area used for the production of summer-annual forages also can be double-cropped by planting temporary winter pastures, such as wheat, rye, oats, triticale or annual ryegrass to provide forage in the late fall, winter and spring.

Forage and Grain Sorghums

Overview. There are many important factors to consider when choosing a sorghum hybrid for silage. These may include yield potential (forage and grain), maturity (full vs. short-season), forage quality and resistance to lodging, disease and insects. Many cultivars of sorghum have been selected, primarily by commercial seed companies, for once-a-year harvest as silage; these varieties are typically tall-growing types that are not really supplemental forages. They are managed much like corn grown for silage and have little regrowth potential, except in the deep South.

Grain-sorghum hybrids, which typically are shorter in height and have higher grain-to-forage ratios than forage types, also are viable options for use as a silage crop. Bird-resistant grain-sorghum varieties, which may contain elevated levels of tannins, should be avoided. Forage-sorghum varieties selected for one-time harvest as silage can take more than 100 days to mature, and are not good options for most Arkansas producers unless they have access to land suitable for row-crop production and the equipment necessary for the establishment, harvest and storage of row-crop silages.

In contrast, sorghum-sudangrass hybrids are not usually established as a row crop. Typically, these hybrids are established by broadcasting or drilling the seed, and they can be harvested as hay, silage or greenchop. Unlike forage and grain sorghums, pearl millet and sorghum-sudangrass hybrids exhibit very active regrowth after the initial harvest, and multiple harvest and/or grazing opportunities are likely. Rotational grazing systems are preferred for these forages.

Seeding Rates. Grain sorghum seed varies greatly in size (11,000 to 27,000 seeds per pound); however, forage sorghums can have as many as 55,000 to 68,000 seeds per pound. This variability with respect to seed size can have a substantial effect on plant population if planting rates are determined on a seed weight per unit area basis. Therefore, planter calibration should be based on desired seed spacing within the row rather than seed weight per unit area.

Planting rates for sorghum silage are similar to those used for grain-type sorghums. Plant populations can range from 70,000 to 100,000 plants per acre when moisture is not limiting. Generally, plant populations per unit area are held constant at the appropriate level for expected soil moisture conditions, regardless of row spacing. Planter calibration normally is based on a 65 to 70 percent emergence rate. Assuming a planter is set up for 30-inch rows, planting one seed every 2 inches would yield a plant population of 70,000 plants per acre. Forage and grain sorghums developed for one-time harvest as silage typically require herbicide strategies to control weeds. Consult the appropriate Extension personnel in your area to develop the most appropriate strategy for your specific situation.

Seeding Date. Planting date is critical for several reasons. Planting sorghum too early, when soil temperatures are too low, subjects the seed to longer attack by soil microorganisms, and can result in delayed emergence, slower initial growth and thin stands. As soil conservation recommendations encourage producers to reduce tillage and retain more crop residue in the seedbed, soil temperatures often remain cooler and the soil may remain wetter than in conventionally-tilled soils; therefore, no-till and reduced-till establishment is best suited to fairly well-drained sites.

Late plantings are more susceptible to reduced dry matter production due to slow grain fill and fall freezes that can occur before the desired maturity level for ensiling is reached. Premature frost also increases the risk of prussic acid poisoning in ruminant livestock if frost-damaged sorghum forage is immediately grazed, used as greenchop or ensiled without field wilting or field drying. Forage or grain-sorghum hybrids can exhibit a wide range in the time necessary to reach harvest maturity as silage. For instance, some hybrids reach half-bloom in as little as 50 days, while others need more than 100 days to reach the same growth stage. Proper varietal selection is an important consideration that can help to limit the risk of frost damage.

Planting Depth. Planting depth for forage-sorghum hybrids normally ranges from 2/3 inch to 2 inches, depending on soil texture and available moisture. Seeds should be planted deep in light, sandy soils that have limited moisture available near the soil surface. Good soil contact with the seed will aid germination. Quick germination and emergence will occur when the soil temperature reaches about 68°F. Sorghum seed is relatively small and this results in a slower initial growth habit, particularly before the growing point reaches ground level at about 30 to 35 days postemergence.

Row Spacing. Row spacing for forage sorghums is usually dictated by the type of harvesting equipment available to the producer; therefore, management decisions are based primarily on logistical, rather than agronomic, considerations. Rows are commonly spaced about 30 inches apart to allow producers to take advantage of direct-cut harvester heads that are designed primarily for corn silage; however, this spacing may need to be adjusted if older harvesting equipment (designed for 36-inch or wider rows) is used.

Recent developments in direct-cut technology that permit row-planted silage crops to be direct cut across or independent of the established rows will allow more flexibility during harvest. Although forage- and grain-type sorghum hybrids also can be successfully established with a drill, subsequent direct-cut harvest options (for silage) are limited. Establishment with a drill is a better option for sudangrasses, sorghum-sudangrass hybrids or pearlmillet, which are not selected for a one-time harvest as silage.

Fertilizer Needs. Fertilizer and lime needs are best determined by soil test supported by both past experience and field history information. Forage sorghums generally perform best when the soil pH ranges from 6 to 7. Harvesting grain sorghum as a silage crop will remove more nutrients from the field than harvesting only the grain; in particular, large quantities of nitrogen, phosphorus, and potassium are consumed (Table 11-1). Generally, nitrogen is the nutrient most likely to be lacking for

Table 11-1. Approximate Amount of Nutrients in a 100 Bushel/Acre Grain Sorghum Crop[1]

Element	Quantity in	
	Grain	Stover
	lbs	
Nitrogen (N)	84	95
Phosphorus (P2O5)	42	20
Potassium (K2O)	22	107
Sulfur (S)	8	13
Magnesium (Mg)	7	10
Calcium (Ca)	1.4	19
Copper (Cu)	0.01	0.02
Manganese (Mn)	0.06	0.11
Zinc (Zn)	0.07	0.14

[1]Source: Adapted from National Plant Food Institute and Vanderlip, et al. (1992).

optimum production. Typical fertilizer recommendations for nitrogen can range up to 180 pounds per acre in situations where no water stress is expected. **The large yields of dry matter that can occur when any summer-annual forage is harvested strictly as hay or silage can quickly lead to depleted levels of soil nutrients. Soil testing and the subsequent fertilizer recommendations provided by the Cooperative Extension Service are an important component of the management needed to utilize these crops effectively.**

Harvest Considerations. Typically, forage sorghums are harvested for silage when the grain is in the mid- to late-dough stages. The moisture content of these forages at mid- to late-dough stage can vary substantially. Ideally, the moisture content at harvest should be less than 70 percent to ensure proper fermentation and prevent excessive effluent losses. Frequently, forage sorghums are not that dry at harvest; these silages can be prone to heavy effluent losses, especially in upright silo types. Under these circumstances, dry matter losses also may be high, and dry matter intakes may be depressed.

Grain-sorghum varieties can be expected to have lower moisture concentrations at ensiling than forage-type sorghums (Table 11-2), which may decrease the risks of undesirable fermentations and production of excessive effluent. Overly mature, whole-sorghum grains can be digested poorly by ruminants and this problem is not adequately resolved by the ensiling process. Excessively dry silages (<60 percent moisture) may be more difficult to chop and pack properly, and drier silages frequently have a shorter bunk life at feedout.

Table 11-2. Agronomic Characteristics of Forage and Grain Sorghums From Studies in Kansas from 1984 to 1995. Adapted from Bolsen et al. (2003).

Trial	Year(s)	Number of cultivars	Type	Statistic	Days to half-bloom	Height	Whole-plant yield	Whole-plant moisture content	Grain yield
					days	feet	tons DM/acre	%	bushels/A
1	1984	6	Forage[1]	Range	- - -	- - -	5.9 - 6.6	68.3 - 75.3	11 - 83
				Average	- - -	- - -	6.2	72.4	51
		6	Grain[1]	Range	- - -	- - -	5.4 - 6.2	54.8 - 60.8	86 - 107
				Average	- - -	- - -	5.8	57.6	99
2	1986	7	Forage	Range	57 - 87	8.7 - 10.9	5.5 - 8.2	65.6 - 74.7	51 - 105
				Average	67	9.2	6.8	70.9	80
		5	Grain	Range	51 - 55	4.2 - 5.2	5.2 - 5.7	64.9 - 66.4	99 - 113
				Average	52	4.7	5.5	66.0	107
3	1986-88	35	Forage	Range	56 - 105	5.9 - 12.3	4.5 - 9.0	62.4 - 76.4	- - -
				Average	74	8.3	6.6	70.7	- - -
4	1986-87	60	Forage	Range	55 - 106	6.3 - 13.5	5.1 - 10.1	64.9 - 76.3	32 - 113
				Average	72	8.7	7.3	71.6	73
5	1990	20	Forage[2]	Range	64 - 83	6.2 - 14.3	5.7 - 8.4	57.0 - 75.5	48 - 124
				Average	74	9.3	7.2	69.2	89
6	1995	37	Forage[3]	Range	- - -	4.8 - 9.3	3.0 - 5.6	60.1 - 77.1	18 - 59
				Average	- - -	6.5	4.6	72.3	45
		3	Grain	Range	52 - 57	3.3 - 3.8	3.1 - 3.8	59.8 - 66.0	43 - 57
				Average	55	3.6	3.5	62.5	53

[1]Entries were harvested at several stages of maturity, but only data from late-dough stage are reported.
[2]One male sterile variety was omitted from calculations of days to half bloom and grain yield.
[3]Twenty cultivars produced no grain because of an early frost. They were omitted from grain yield data.

Agronomic Characteristics

It is important to remember that forage-sorghum varieties vary widely with respect to agronomic characteristics. In a summary of tests conducted in Kansas (Table 11-2), forage sorghums ranged from 5.9 to 14.3 feet tall, and whole-plant yields ranged between 3.1 and 10.1 tons of dry matter per acre. Tall-growing forage sorghums are prone to lodging, which can make harvest as silage nearly impossible with conventional row-type harvesters. Generally, the chances of lodging are decreased in shorter plants and/or in plants with larger stalk diameters. Some producers routinely use higher planting rates to limit stalk diameter and improve forage quality, but this practice can increase the risk of lodging.

Grain-type sorghums are typically shorter than forage types (< 5 feet) and the chances of lodging are greatly reduced. Whole-plant yields for grain-type sorghums are up to 35 percent less than those observed for forage types grown in common environments. Producers should be cautious about relying extensively on grain sorghums for silage production because dry matter yields can be greatly reduced in dry years. Grain yields for forage sorghums are often competitive with those of shorter grain types; however, the proportion of grain in the total silage mass is frequently less.

Forage Nutritive Value

Generally, the nutritive value of forage sorghums is far more variable across hybrids than that observed for grain sorghums. Forage-sorghum hybrids that require longer to develop, grow to tall plant heights and exhibit low grain-yield potential have poorer nutritive value than other types. The crude protein content of grain and forage sorghums can range from about 6 to 11 percent; however, grain-type hybrids typically have crude protein concentrations that are 1.0 to 3.0 percentage units higher than observed for forage types.

Neutral detergent fiber (NDF) and acid detergent fiber (ADF) fractions are generally lower in grain-type sorghums because the stover is diluted by the higher grain-to-stover ratios common to grain-type varieties. In addition, grain-type sorghums are frequently more digestible because the proportion of grain in these plants is larger than in forage types. Between the milk and hard grain stages of growth, grain yield usually increases. This may cause concentrations of NDF and ADF to remain stable or decrease with maturity, which is unusual compared to most other forages. While these trends can be observed in both grain and forage types, responses tend to be more pronounced for forage sorghums. Quality characteristics of forage and grain sorghums from tests conducted in Kansas are summarized in Table 11-3.

Feeding Comparisons

Comparisons of performance by growing cattle consuming corn, grain sorghum and forage sorghum silage diets are shown in Tables 11-4 and 11-5. Generally, average daily gains were higher and feed-to-gain ratios were lower for cattle consuming corn silage compared to either grain or forage-sorghum silage diets. When forage-sorghum hybrids had relatively low concentrations of ADF (Table 11-4), performance of cattle consuming grain-sorghum and forage-sorghum silages differed only minimally. However, when forage-sorghum hybrids were higher ADF types (Table 11-5), cattle consuming grain-sorghum silage gained 0.65 pounds per day more than cattle consuming forage-sorghum silages. The feed-to-gain ratio for cattle consuming these high-ADF forage-sorghum silages was 8.2, which compared poorly with the 7.0 and 6.0 observed for grain-sorghum and corn silages, respectively.

Prussic Acid and Nitrates

Prussic acid and nitrate poisoning may be a problem with most summer-annual forages. The prussic acid potential is high in the early stages of growth and decreases steadily in the fall until frost. It remains dangerous to livestock after frost until these plants are completely dry. This may take from one to seven days. Prussic acid concentrations are high in the leaves. Therefore, short, leafy plants have a higher prussic acid potential than tall, coarse ones. For this reason, the risk of prussic acid poisoning is greater in immature plants or in vegetative regrowth. Prussic acid can be reduced by up to 70 percent by field-wilting prior to conservation as hay or silage.

Nitrogen fertilization increases the total nitrogen, prussic acid and nitrate content of summer-annual forages. Nitrogen fertilizer should be applied with caution on any site that is drought

Table 11-3. Nutritive Value of Forage and Grain Sorghums From Six Comparative Studies in Kansas from 1984 to 1995. Adapted from Bolsen et al. (2003).

Trial[1]	Year(s)	Number of Cultivars	Type	Statistic	Crude Protein	NDF	ADF	Digestibility
					%			
1	1984	6	Forage[2]	Range	5.7 - 8.7	- - -	- - -	- - -
				Average	7.6	- - -	- - -	- - -
		6	Grain[2]	Range	8.8 - 10.5	- - -	- - -	- - -
				Average	10.1	- - -	- - -	- - -
2	1986	7	Forage	Range	6.6 - 7.8	47.3 - 60.0	29.6 - 38.5	52.3 - 58.7[3]
				Average	7.3	55.1	33.1	56.5[3]
		5	Grain	Range	9.0 - 9.8	41.9 - 48.0	22.6 - 27.5	60.7 - 63.8[3]
				Average	9.4	43.4	24.5	61.8[3]
4	1986-87	60	Forage	Range[4]	4.7 - 8.2	46.2 - 69.9	25.7 - 44.9	47.6 - 64.7
				Average[4]	6.7	54.6	33.3	56.3
6	1995	37	Forage[5]	Range	7.2 - 10.1	45.1 - 58.0	28.2 - 36.5	- - -
				Average	8.4	51.9	31.9	- - -
		3	Grain	Range	10.1 - 10.8	42.5 - 49.4	26.0 - 29.3	- - -
				Average	10.4	46.8	27.9	- - -

[1]Trial numbers correspond to those in Table 11-2.
[2]Entries were harvested at several stages of maturity, but only data from late-dough stage are reported.
[3]Determined as silage in sheep.
[4]Averaged over years. Analysis performed on fermented silage.
[5]Twenty cultivars produced no grain because of an early frost.

Table 11-4. Feeding Comparisons of Growing Cattle Consuming Corn, Grain Sorghum or Forage-Sorghum Silages. Forage Sorghum Performance Is Averaged Over Three Low-ADF Hybrids. Adapted from Bolsen et al. (2003).

	Silage Type		
Item	Corn	Grain Sorghum	Forage Sorghum
Initial weight, lbs	640	644	634
DM intake, lbs/day	19.0	19.9	18.9
Average daily gain, lbs/day	2.67	2.43	2.32
Feed:gain, DM basis	7.1	8.2	8.2
Silage moisture, %	66.7	62.3	63.1
Silage ADF, %	23.4	25.1	28.9

Table 11-5. Feeding Comparisons of Growing Cattle Consuming Corn, Grain Sorghum or Forage-Sorghum Silages. Forage Sorghum Performance Is Averaged Over Four High-ADF Hybrids. Adapted from Bolsen et al. (2003).

	Silage Type		
Item	Corn	Grain Sorghum	Forage Sorghum
Initial weight, lbs	569	569	568
DM intake, lbs/day	17.2	18.3	15.9
Average daily gain, lbs/day	2.87	2.60	1.95
Feed:gain, DM basis	6.0	7.0	8.2
Silage moisture, %	70.0	63.8	67.9
Silage ADF, %	24.2	27.8	35.3

prone. Forages that have been grown under stress can be tested inexpensively for nitrates in the laboratory.

When harvesting forages that are known or suspected to have dangerous levels of nitrates, a good management practice is to raise the cutter bar to a 6- to 12-inch height. This is effective at reducing nitrates in the harvested forage because most nitrates tend to accumulate in the lower portion of the stalk. In addition, silage fermentation can be used as a management tool; the fermentation process will normally reduce the concentration of nitrates in forages by about 50 percent. Testing for prussic acid is more expensive, and comparatively few laboratories offer this service.

References

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