Forage Sorghum Production Guide

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Introduction

The use of Sorghum has increased in recent years due to the fact that Sorghums require 1/3 to 1/2 less water than corn and is better adapted to most regions in Texas. In addition, quality of sorghums for forage have improved. Sorghums used for forage are typically grouped as a) forage sorghum, b) sudangrass, and c) sorghum-sudan hybrids. Each of these types has different growth characteristics that influence how they should be used. Even within a type, considerable differences can exist between varieties. Typically, forage sorghums are used for silage production or for a one cutting hay crop. Sudangrass is most often used for grazing, multiple hay cuttings, or occasionally greenchop. Sorghum-sudan hybrids are best utilized for single or multiple hay cuttings and grazing. A new development in the last few years has been the introduction of photoperiod sensitive and brown mid-rib forage sorghums and sorghum-sudangrass hybrids. The introductions of these two traits may very well change how we utilize sorghums for forage.

Sorghum Descriptions

Forage sorghums. Forage sorghums are often referred to by producers as 'Cane' and have similar characteristics to grain sorghum. Historically forage sorghums have been associated with relatively small grain heads. However, more recently developed cultivars can produce grain yields similar to that of good grain sorghum hybrids. In irrigated trials grain yield of forage sorghum hybrids have ranged in yield from 1,100 lb to 10,000 lb per acre. Forage sorghums are typically taller, more leafy, and later maturing than grain sorghum hybrids. Many of the forage sorghums have a 'sweet stalk' making them more palatable to livestock when utilized for grazing or for hay. The stalks of forage sorghum tend to be large and succulent, making them less palatable for grazing and sometimes slow in drying down for hay production. Their regrowth potential is not as good as the other types of sorghums making them more suitable for a one time hay cutting or for silage production. The forage sorghums are capable of producing very high amounts of dry matter per acre.

Sudangrasses. Most sudangrass cutivars now sold are hybrids. Sudangrasses have smaller stems and more slender leaves than the forage sorghums. They are used almost exclusively used for grazing, multiple hay cuttings or possibly greenchop. They have excellent regrowth potential, but total dry matter produced in any single cutting will likely be less than the other types of sorghum.

Sorghum-sudan hybrids. As the name suggests these hybrids are a cross between sorghum and sudangrass. These are often called 'Haygrazers' by producers and may or may not have a sweet stalk. They tend to take on characteristics intermediate between

forage sorghums and sudangrass. Grain heads produced will look more like sudangrass (a Johnsongrass looking head) than grain sorghum. Grain yield will be much lower and than that produced with forage sorghums. Regrowth potential is intermediate. Sorghum-sudan hybrids in Texas are used for grazing, single or multiple hay cuttings, and greenchop. Although they are sometimes used for silage, Texas studies have shown yield and quality are generally less than that achieved with forage sorghums.

Brown midrib BMR Sorghums. Brown midrib- term used to describe forages (sorghum-sudan, forage sorghum, corn, and millets) that have lower % lignin and thus should have higher % digestibility (Table 1). The name refers to the brown coloration in the midrib of the plant, however, this brown coloration is just a tool to identify the cultivars that have this new genetics for lower lignin. The degree of color has no meaning to relative degree of digestibility and is therefore meaningless. 25-50% less lignin increases digestibility as well as palatability. There is usually a trade-off with silage types having a high percentage of lodging when plant reaches soft dough stage due to the weaker stems associated with less lignin.

Table 1. Quality of Conventional and Brown Midrib Forage Sorghum and Corn

Component	Conventional n=25	Brown Midrib n=20	Corn n=4
% CP	8.3	9.2	9.0
range	6.3-10.8	6.9-10.5	8.4-9.7
% ADF	29.9	27.6	23.9
range	21.3-41.7	24.3-35.0	18.2-27.4
% NDF	49.1	45.9	41.2
range	33.9-67.5	40.7-60.1	33.7-45.8
% Lignin	4.4	3.6	3.5
range	2.7-6.4	2.8-4.5	2.7-4.2
% IVTD	75.5	81.3	82.7
range	60.9-83.6	75.1-84.2	78.3-88.1

Source: Data from Bean et al. 2001. http://soilcrop.tamu.edu/publications/grainsorghum.html

Table 2. Performance of Midlactation Cows on Brown Midrib Sorghum Sudan Grass

Item	Conventional Sorghum	Brown Midrib Sorghum	Conventional Corn
Milk (kg/day)	20 b	26 a	26 a
Fat (%)	3.5 b	4.0 a	4.3 a
Fat (kg/day)	0.7 b	1.1 a	1.1 a
Protein (%)	3.2 b	3.2 ab	3.3 a
Protein (kg/day)	0.6 b	0.8 a	0.9 a
Lactose (%)	4.7 b	4.9 a	4.8 ab
Lactose (kg/day)	1.0 b	1.3 a	1.3 a

Source: Data from Grant et al. 1995

There is significant variability in % lodging in both non and BMR sorghum (Table 3). It is very important to select those varieties that have lower lodging potential , which will be a must for silage type sorghums. On average there is currently about a 10% yield drag with many of the commercial BMR sorghums, however, the increased quality will be advantageous when quality is needed (i.e. silage for lactating dairy cows) (Table 2). There is also an increase cost associated with this new technology, therefore the type of livestock to be fed (nutrient requirement) should dictate which sorghum is to be used.

Table 3. Percent lodging and yield of selected conventional (C), Brown Midrib (BMR), photoperiod sensitive (PS) sorghums, and corn.

Variety	Type	% Lodging	Yield Tons/A
FS5	C	0	28.4
Canex II	C	0	22.9
979	C	25	25.3
Silo N Feed	C	60	34.6
2 Way SRS	C	77	23.6
Canex 702	BMR	0	14.6
Millenium	BMR	13	27.2
Garst 344	BMR	40	36.7
BMR 101	BMR	80	27.3
Maxi-Gain	PS	0	41.0
MegaGreen	PS	0	27.2
Corn	C	0	23.8

Source: Data from Bean et al. 2001.

Photoperiod Sensitive (PS) Sorghums. Flowering is initiated in plants in response to day length (actually the duration of night) or photoperiod. Plants have different requirements and are categorized by: long-day, short-day, or day neutral. The PS sorghums will not initiate flowering until the day length becomes less than approximately 12 h and 20 minutes. This means the plant will remain vegetative from mid-March to mid-September in central Texas. Even after the plant enters the reproductive stage (flowering initiated) it will take 3 to 4 weeks for the plants to actually head out. In the Texas Panhandle region a fall freeze will generally kill the plant before heads will ever emerge from the whorl of the plant. These plants tend to be very tall if allowed to continue to grow.

The advantage of the photoperiod sensitive trait is that since the plants remain in the vegetative state for a long period of time the plants will continue to add leaves and remain high in quality. By remaining in the vegetative stage longer, this allows for harvesting higher quality forage and more flexibility as to when the forage must be harvested. Typically, quality drops significantly once the sorghum plant initiates flowering. Recent data suggest

PS sorghums should be harvested on a 70-day interval to maximize yield, due to its regrowth potential. However, if a one time cutting is desired, the PS trait greatly increases the window for when the forage can be harvested without sacrificing quality.

Antiquality Factors

Prussic Acid Poisoning. Most Sorghums contain varying amounts of cyanogenic glucosides, which depend on the variety, growth stage, and environmental conditions. Cyanogenic glucosides can be hydrolyzed into hydrogen cyanide (HCN). Small plants, young shoots, tillers, and especially new regrowth are high in these glucosides. During any weather stress these tender shoots can poison livestock. If sorghum is cut for hay and sun-dried the HCN is rapidly volatilized, and can be fed to livestock. If conditions are unfavorable and there is a question, plants can be analyzed at a certified lab – if HCN > 500 ppm (DM basis) then the plants should not be grazed or fed.

Nitrate Poisoning. Sorghums can accumulate nitrates (NO_3) during any weather condition that interferes with normal plant growth, however drought is the most common cause. This NO_3 is converted to nitrite (NO_2) in the rumen, which diffuses out into the bloodstream and binds to hemoglobin. This prevents the transport of oxygen (O_2) causing the animal to die from oxygen depravation. Most NO_3 accumulate in the stem or lower portion of the plant. If NO3-N exceeds 0.35% it should either be disregarded or diluted with safe feed (preferably grain). Unlike HCN, NO_3 will NOT leach out by the sun, however ensiling the forage can lower the NO_3 by approximately 50%.

Proper Fertility

A soil sample should be taken to determine how much fertilizer should be added based on the desire yield goal (Table 4). The yield goal for forage sorghum silage will be dependant on how much rainfall received or irrigation is applied. Due to the potential for nitrate accumulation it is recommended that no more than 75 lb N/A be applied during each harvest for hay or grazing period.

Table 4. Estimated nutrient requirements for forage sorghum silage and sorghum-sudan hay (Texas A&M University Soil, Water and Forage Testing Laboratory)

Hay					**Silage**			
	N	P_2O_5	K_2O		**35%DM**	N	P_2O_5	K_2O
	lbs				**tons/A**	lbs		
Each Harvest	75	65	80		**10**	90	65	80
					15	135	85	100
					20	180	95	120
					25	225	100	140
					30	270	105	160

Selecting a Variety

Which type of sorghum and variety chosen for planting will depend on if the intended use is for grazing, hay, greenchop or silage. Other considerations will be are you feeding your own livestock, will the forage be used for maintainance only, or is maximum weight gain or milk production important, and if selling the forage, what is the buyers intended use and will the buyer pay for quality.

Grazing

Sorghum-sudangrass and sudangrass hybrids are most often used for grazing because of their regrowth potential. They also tend to have less risk associated with prussic acid than the forage sorghums. The goal of grazing should be to keep the forage in an early vegetative stage in order to maximize quality. If the forage is allowed to grow too much before grazing, quality will go down. In addition, cattle tend to waste tall forage by trompling over it. Ideally cattle should be allowed to graze sorghum-sudan hybrids when they reach a height of 20 – 30 inches and sudangrass at a height of 15 to 20 inches. Sudangrass can be grazed earlier because it has less prussic acid potential. Prussic acid develops in sorghum plants that are under stress and accumulates in new leaves.

Table 5. Performance of stocker heifers grazing a sorghum x sudan hybrid in either a continuous or rotational system. Banta et. al. 2002?.

	Continuous	**Rotational**
Initial weight, lbs.	455	451
Average daily gain, lbs.	2.44	2.45
Gain per acre, lbs.	320	345
Head days/acre	130.8	140.8
Grazing length, days	72	80

It is often difficult to stock pastures heavy enough to take advantage of the rapidly growing forage. For this reason it is desirable to subdivide the field into three or more smaller pastures or paddocks. The date that each paddock is planted should be staggered in 10 to 14 day intervals. Cattle can then be placed on the first planted paddock, grazed for 7 to 10 days at a high number of head per acre, and then rotated to the next paddock. Number of cattle on the paddock should be sufficient to graze the forage down to a height of 6 inches in a 7 to 10 day period before moving to the next paddock. Do not place cattle back on the grazed paddock until the forage has reached a height of 18 inches. This rotational system allows for maximum production. In Table 5 average daily gain was the same for cattle in a continuous grazing system compared to a rotational system. However, eight more days of grazing was achieved with the rotational system allowing for gain per acre to be 25 lbs more compared to the continuous system. Excellent cattle gains can be achieved using sorghums as a pasture if managed properly. The key is to not over graze the pastures.

Sorghums for grazing can be planted either with a drill or in wider rows. If a drill is used consider plugging drill rows to allow for an 18 to 20 inch spacing between rows. This will allow room for cattle to walk and will prevent forage from be lost by being trampled on by the cattle.

Table 6. Recommended seeding rates for sorghum.

		Dryland		Irrigated	
	Seed per lb	Row Spacing			
		20-40	6-20	20-40	6-20
Forage Type		Lb/Ac			
Sorghum-sudan	24,000-26,000	8	15	12	20
Sorghum-sudan	20,000-22,000	9	17	13	22
Sorghum-sudan	16,000-17,000	10	18	15	25
Forage sorghum - silage	~16,000	8	-	12	20
Forage sorghum - grazing	~16,000	12	18	20	25
Brown mid-rib	~16,000	7-10	10-15	10-15	18-25
Photoperiod sensitive	~16,000	10	18	15	25

Notes: Seeding rates for ~20@ rows might be intermediate in lbs./A.

Hay Production

High seeding rates are desirable in order to decrease the size of the stalks. A smaller stalk will dry quicker after cutting. Seeding rate recommendations will vary depending on water availability and row spacing (Table 6). Because of the increased digestibility of the BMRs stalks a lower seeding rate can be used. A lower seeding rate will also tend to decrease the potential for lodging of the BMR plants if harvesting is going to be delayed until heading in order to maximize yield in single cutting hay crops.

Multiple Cuttings. Because of its rapid regrowth potential, sorghum-sudan hybrids are often used for hay production if multiple cuttings are desired. Sudangrass is sometimes used, but overall yield is usually less than with the sorghum-sudan hybrids. In order to obtain multiple cuttings planting will need to be as early as possible. Optimum soil temperature for sorghum seed germination is considered to be between 70 and 75 F. However, if early planting is desired seed will germinate once soil temperatures are above 60 F.

Single Cutting: Either sorghum-sudan hybrids or forage sorghums can be used. Forage sorghums often have higher yield potential for single cutting hay crops. Keep in mind that stalks of forage sorghums are larger and may require more drying time. BMR forage sorghums varieties may be desirable in that their stalks are more palatable and digestible than conventional forage sorghums.

When to harvest sorghums for hay will depend on if maximum yield is desired or if maximum quality is the most important consideration. Due to differences in maturities, it is difficult to number of days after planting that harvesting should occur, it is best to use the growth stage/development of the plant. Traditionally it is recommended to harvest in the 'at-boot' stage or prior to boot to optimize both quantity and quality.

Typically, hay should be harvested and allowed to dry to 15-20% moisture before baling. If moisture is too high, hay can either form mold or the temperature can exceed 120°F and the protein

can become “heat bound”, which is unavailable to microbes in the rumen. It is also important that hay not be in contact with soil surface (as microbes will break down the hay

Silage Production

Harvest and storage

Silage must be stored in anaerobic conditions (for proper fermentation to occur) for at least 21 days. Excluding the air is the first and most important step: to do this, silage should be finely chopped (½”), packed adequately, and remain anaerobic until time of feeding. Rapid removal of air prevents growth of unwanted aerobic bacteria, yeast, and mold that compete with desirable bacteria for substrate.). If moisture is too high during the ensilage process there will be excessive seepage and loss, whereas, if moisture is too low, there will not be rapid lowering of the pH (3.8-4.2). This rapid decrease in pH is essential for lactic acid bacteria (needed for proper fermentation), limiting the breakdown of protein, and for inhibiting undesirable microorganisms (*Clostridia* sp.).

There have been mixed results with inoculating silages to improve silage quality, increase intake and digestibility. If silage is properly made, there should be adequate concentrations of desirable bacteria (lactic acid bacteria) present. However, adding an inoculant is good insurance to ensure adequate concentrations of bacteria to aid in the fermentation process. If silage is stored in a bunk or large pile it is important to add the inoculant to the forage when it is chopped. This will maximize the amount of time that microbes have in contact with fermentable substrates and ensure adequate distribution of microbes on the silage.

Planting in narrow rows at a relatively high seeding rate is desired for silage production. Typically the narrower planted forage will produce higher yields, however, this is dependant on rainfall and environmental conditions. With adequate moisture (year 2001) narrow rows in central Texas produced substantially greater forage (Table 7); however, when moisture becomes limited these differences diminish.

Table 7. Effect of row spacing of forage sorghum silage planted at 8 lb/A and harvested in the dough stage

	Growing year	
Row Spacing	2001†	2002‡
12 in	24.0 a	21.4 a
18 in.	19.1 b	19.0 b
36 in.	16.0 c	15.7 c
LSD	1.9	1.0

† 2001 irrigated conditions, TAEX, Stephenville.
‡ 2002 non-irrigated, adequate moisture, TAEX, Stephenville.
Source: Butler, 2002.

When should the Forage Sorghum be harvested for silage?

Harvesting forage sorghums at dough stage maximizes total production and optimal quality due to increased energy associated with the grain (Table 8). Although the CP is lower, the lower NDF (relative measure of intake) and ADF (relative measure of digestibility) indicates that quality is maximized at the dough stage.

Table 8. Effect of harvest maturity and ensilage on forage nutritive value averaged over three forage sorghum varieties and three row spacings at the Stephenville Experiment Station in 2002

	Stage						
	Boot	Early Head	Early Dough	Mid Dough	Late Dough	Hard Seed	LSD
Yield @35% DM	9.3	12.7	14.5	18.7	20.2	20.3	0.90
CP %	9.7	8.9	7.8	7.4	6.8	6.5	0.50
ADF %	40.6	38.0	35.4	33.4	31.1	32.4	0.75
NDF %	69.3	66.1	61.6	60.0	55.6	57.8	1.25
Lignin %	3.4	4.1	3.7	3.8	3.6	4.3	0.25