Annual warm-season grasses can be used as part of a year-round grazing system throughout Missouri. With adequate moisture and fertility, they rapidly produce high-quality forage during late spring and summer when cool-season forages are dormant. In addition, warm-season annual grasses work well in rotation with row crops or as emergency pastures. Although many annual crops are used for summer grazing, pearl millet (Pennisetum americanum), sorghum-sudangrass (Sorghum bicolor) hybrids, and crabgrass (Digitaria sanguinalis) are the most common. Hay-feeding trials at the Southwest Center of the Missouri Agricultural Experiment Station indicate that properly supplemented animals could gain 1.6 to 1.8 pounds per day on sorghum-sudangrass and pearl millet. Similar data have been reported for crabgrass.

Sudangrass and sorghum-sudangrass hybrids

True sudangrasses have been used extensively in the past, but their use has declined with the development of sorghum-sudangrass hybrids. Sorghum-sudangrass is a hybrid developed by crossing forage sudangrass with true sudangrass. Forage sorghums are often tall-growing and stemmy. They should not be confused with milo, which was developed by selecting for short stalks with large heads and a high harvest index. Forage sorghum was crossed with sudangrass to increase leafiness and forage production while minimizing seed set.

There is little difference in yield among sudangrass or sorghum-sudangrass cultivars, and most variation in yield can be attributed to differences in moisture availability. Piper is the most widely used cultivar largely because it is reported to have less prussic acid than other cultivars. Several other proprietary hybrids perform well, so seed cost and availability should be strongly considered when selecting varieties.

Sorghum-sudangrass is intolerant of low soil pH and should be planted only on land with a soil pH above 5.5. It should be seeded during May at 30 to 35 pounds per acre when broadcast onto a prepared seedbed or 20

Sorghum-sudangrass seed head (left) and shoot (right).

Sorghum-sudangrass at a glance

Common names: Sudangrass, sorghum-sudangrass, forage sorghum
Origin: Northeastern Africa
Adaptation to Missouri: Statewide
Growth habit: Tall, upright
Tolerance to drought: Good
Tolerance to poor drainage: Good
Cultivars: Several proprietary hybrids and brown midrib types are available — see your seed dealer for options
Ease of establishment: Easy
Seeding rates: 20–25 lb/acre drilled; 30–35 lb/acre broadcast
Seeding dates: May 1 to June 30
Preferred seeding depth: 1/2 to 1 inch
Days from seeding to first grazing: 45–60
Preferred soil pH: 5.5 or higher
Fertilization: 60–90 lb of N/acre at establishment. Apply 40–60 lb of N after each cutting or grazing thereafter. P and K to soil test.
Timing of production: 90% of production occurs in June, July and August
When to begin grazing: When it reaches 24 inches (Note: To avoid prussic acid poisoning, do not graze when it is shorter than 24 inches. It is also best to delay grazing for 14 days after frost or drought stress.)
When to cut for hay: When it reaches 30–36 inches
Lowest cutting or grazing height: 10 inches
Suitability for wildlife cover: Poor
to 25 pounds per acre when drilled in 7- to 15-inch rows. No-till establishment works well if weed and sod competition are controlled with a burndown herbicide at seeding.

**Pearlmillet**

Pearlmillet is an excellent choice for warm-season pasture because it tolerates acidic soils and drought. Unlike sorghum-sudangrass, it does not contain prussic acid. Other millets, such as proso, foxtail or German, are often used in silage or hay mixtures. However, they produce less forage and have a shorter grazing season than pearlmillet.

Pearlmillet is typically drilled at 15 pounds per acre or broadcast into a prepared seedbed at 20 to 30 pounds per acre from May 1 through the middle of June. The major factor limiting the time of establishment after mid-June is the availability of moisture. Therefore, seeding before the beginning of summer is recommended because of the decreasing probability of rainfall as summer progresses.

Widely available cultivars include Tifleaf I, Tifleaf II, Mil-Hy-300 and Sunny State. Like sorghum-sudangrass cultivars, pearlmillet cultivars show little difference in yield. Therefore, cultivars should be selected on the basis of seed price and availability.

**Crabgrass**

Although commonly considered a weed in row crops, crabgrass provides high-quality summer forage and grazing. It is gaining popularity because it can be used alone, double-cropped behind winter annual pastures, or used in combination with perennial cool-season grasses. Like pearlmillet, crabgrass does not contain prussic acid.

Productivity of crabgrass is determined by the availability of moisture. When planted as a single crop with good growing conditions and adequate moisture, crabgrass can yield 4,000 to 8,000 pounds of dry matter per acre. The improved cultivar Red River has yielded 8,000 to 10,000 pounds of dry matter per acre under optimum growing conditions.

Although many stands of crabgrass are natural ecotypes, improved cultivars can be established by seeding 3 to 4 pounds of seed per acre in April. Crabgrass seed can be broadcast with fertilizer and then lightly harrowed. Remember that the seed are small and light and will not broadcast farther than 25 feet from most fan-type spreaders. Crabgrass can also be established using a no-till drill, but because the seed are small, they should not be planted deeper than ¼ inch.

Managed properly, this annual grass can persist as a perennial through natural reseeding. To ensure natural reseeding, livestock should be removed at least 3 weeks before the first killing frost to allow seed to set. The following spring, the ground should be lightly scratched with a disk or harrow in late April or early May to provide adequate soil-seed contact. An application of 40 pounds of nitrogen per acre will speed development of a stand.

Animals perform best on crabgrass pasture if it is grazed rotationally. This allows the producer to keep the forage in a high-quality, vegetative growth stage. Ideally, it should be grazed before it reaches a height of 8–10 inches and not grazed to less than 3 inches. Beef cattle have gained up to 2.25 pounds per day on good crabgrass pasture and have repeatedly gained 0.2 pound per day more on crabgrass than on bermudagrass.
Hay curing is difficult with either pearl millet or sorghum-sudangrass because of large stem size. It is imperative that a mower-conditioner be used to crush the stems to speed drying.

Sorghum-sudangrass can produce 4 to 8 tons of forage per acre when harvested to a 6- to 10-inch stubble. It should be harvested each time the accumulated growth reaches a height of 24 to 36 inches. Maximum yield of sorghum-sudangrass is obtained if stubble height is maintained at 10 inches to allow for regrowth to originate from terminal buds rather than from buds at the base of the plant.

Allowing forage to accumulate above 24 inches will result in stemmy, lower-quality forage. The crude protein content of these grasses falls rapidly after they reach a height of 36 inches and heads begin to emerge. Crude protein content can easily be reduced from 12–14 percent in the vegetative growth stages to 6–7 percent when the grasses reach the dough stage. Digestibility follows a similar pattern; it will be higher for new cultivars that express a brown midrib trait. The brown midrib indicates low concentration of lignin, which is a part of the fiber that is not digested well.

Harvest management for pearl millet is much the same as for sorghum-sudangrass, except that pearl millet is more dependent on terminal buds for regrowth. For this reason, pearl millet should be cut at a higher stubble height (8 to 12 inches) than sorghum-sudangrass to ensure maximum yields. Pearl millet regrows slower than sorghum-sudangrass, and the rate of regrowth can be greatly reduced by cool weather.

**Key harvest suggestions include the following:**
- Do not attempt to make hay without using a mower-conditioner.
- It is impossible to overcrush sorghum-sudangrass and pearl millet stems.
- Use more roller pressure than is used on other hay crops and drive in low gear.
- Do not windrow until all plants on the top of the swath are dry enough to bale (15 to 18 percent moisture).

Because of difficulties with hay curing, grazing is the best way to make use of these highly productive forage crops. Grazing trials conducted at the Southwest Missouri Center in the late 1960s and early 1970s indicated that these forages can support average daily gains (ADG) of 1.4 to 1.7 pounds per day over a 90-day grazing season from June through August.

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**Crabgrass at a glance**

- **Common name:** Crabgrass
- **Origin:** Southern Africa
- **Adaptation to Missouri:** Statewide
- **Growth habit:** Sod forming
- **Tolerance to drought:** Fair
- **Tolerance to poor drainage:** Poor
- **Cultivars:** Red River, Common
- **Ease of establishment:** Easy
- **Seeding rates:** 3–4 lb/acre
- **Seeding dates:** May 1 to May 31; can be overseeded into winter annual grasses from late winter to early spring
- **Preferred seeding depth:** ¼ to ½ inch
- **Days from seeding to first grazing:** 30–45
- **Preferred soil pH:** 5.5 or higher
- **Fertilization:** 40 lb of N/acre at establishment. Apply 60 lb of N after first cutting or grazing. P and K to soil test.
- **Timing of production:** 80% between mid-June and August
- **When to begin grazing:** Before it reaches 8–10 inches
- **When to cut for hay:** Boot stage, approximately 10–12 inches
- **Lowest cutting or grazing height:** 3 inches
- **Suitability for wildlife cover:** Poor

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**Harvest management**

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Because of difficulties with hay curing, grazing is the best way to make use of these highly productive forage crops. Grazing trials conducted at the Southwest Missouri Center in the late 1960s and early 1970s indicated that these forages can support average daily gains (ADG) of 1.4 to 1.7 pounds per day over a 90-day grazing season from June through August.
Soil fertility

Soils should be tested before establishing pearlmillet and sorghum-sudangrass; phosphorus and potassium should be applied according to test recommendations before planting. These forages respond well to nitrogen and should receive 60 to 90 pounds of nitrogen per acre at establishment.

Both sorghum-sudangrass and pearlmillet have shown yield responses up to 400 pounds of nitrogen per acre. Sorghum-sudangrass tends to yield more than pearlmillet at the same nitrogen rate. Best results are obtained by splitting nitrogen applications such that part of the nitrogen is applied when the crop is established and another 40 to 60 pounds per acre are applied after the first grazing. Split application improves the efficiency of using nitrogen fertilizer, provides more even forage production, and reduces the potential for nitrate toxicity due to overfertilization. Care must be taken with these forages to avoid nitrate toxicity. Excessive nitrogen fertilization is the key cause of nitrate toxicity.

Crabgrass also responds well to high rates of nitrogen application. Studies show that crabgrass responds to nitrogen rates as high as 200 pounds per acre, but most producers apply 70 to 100 pounds per acre per year for maximum economic returns. Nitrogen applications should be split — half when plants begin to grow in May and the rest in early July.

Livestock toxicities

Nitrate toxicity

Heavy nitrogen fertilization followed by drought is the most common situation that causes nitrate accumulation in forage. Shading and cool, cloudy weather can also contribute to this problem. These environmental conditions result in nitrate accumulation because growth is limited while nitrate uptake continues. In cattle, nitrates are reduced to nitrite in the rumen. Nitrites are toxic to livestock because they interfere with the ability of blood to carry oxygen.

The rate of nitrate incorporation in plants is regulated by the nitrate reductase enzyme. Molybdenum is a key part of nitrate reductase. If plants are deficient in molybdenum, nitrate reduction is inhibited, potentially resulting in nitrate toxicity. The availability of molybdenum to plants is determined by soil acidity. Liming to desirable pH levels of 5.5 to 6.0 is usually sufficient to overcome molybdenum deficiency and alleviate this potential cause of nitrate toxicity. Nitrates are typically concentrated in the lower portion of the stem, so care should be taken to keep animals from consuming large amounts of the lower part of the stalk of these forages when nitrate concentrations may be high.

If plants contain more than 1.5 percent nitrate (15,000 parts per million), they should be considered toxic to livestock. Nitrates will persist in harvested hay since they do not break down during the curing process. If nitrate accumulation is suspected, forage should be tested before feeding. Pregnant and young animals are particularly sensitive to nitrate toxicity. Care should be taken when feeding forages containing greater than 0.25 percent nitrate (2,500 ppm) as a percentage of dry matter to these animals. Forages containing 0.25 to 0.5 percent of dry matter as nitrate should make up no more than one-fourth of the total ration (see Table 1). Forages with 0.5 to 1.5 percent nitrate should make up no more than one-fourth of the total ration, and livestock should receive supplemental energy, minerals and vitamin A.

Prussic acid poisoning in sorghum-sudangrass

A potential problem with sorghum-sudangrass is prussic acid, or cyanide poisoning. When sorghum-sudangrass plants are injured or under stress, enzymes that convert glycosides to sugar and prussic acid are released. Levels of cyanide greater than 2 mg/kg (2 ppm) of dry plant tissue are considered potentially dangerous. Prussic acid is readily absorbed into the bloodstream and causes toxicity by blocking normal cellular respiration in the animal.

The environmental conditions that favor toxic levels of prussic acid are drought stress and frost damage. If sorghum-sudangrass is under drought stress, avoid grazing until the plants have recovered and exhibit at least 24 inches of regrowth. Following a severe frost,
avoid grazing sorghum-sudangrass for 14 days or until the leaves turn brown, whichever is longer.

In addition, prussic acid levels are highest in young, leafy tissue, whether it is initial growth after planting or regrowth after clipping. Since it is the young, fast-growing tissue that contains dangerous levels of prussic acid, avoid grazing until the plant reaches a height of at least 24 inches to allow prussic acid to dissipate. Unlike nitrates, which are persistent, prussic acid disappears during the hay curing or ensiling process.

Prussic acid can be detected through the use of picrate strips. Filter paper that has been treated with a solution of picric acid and allowed to dry is suspended in a test tube over a sample of plant material that has been treated with a few drops of chloroform. The test tube is then incubated for several hours. If prussic acid is present, the yellow sodium picrate paper will turn increasingly red in direct proportion to prussic acid concentration.

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**Key points in management of warm-season annual grasses**

- Warm-season annuals should be seeded when soil temperatures reach 55 to 60 degrees F in late spring while available moisture is still high.
- Before the crop is established, phosphorus and potassium fertilizer should be applied according to soil test recommendations.
- Pearlmillet should be used in preference to sorghum-sudangrass on droughty or more acidic sites.
- For sorghum-sudangrass and pearlmillet, nitrogen should be applied at 60 to 90 pounds per acre at establishment with additional applications of 40 to 60 pounds of nitrogen per acre after each grazing or harvest to obtain maximum yields.
- For crabgrass, nitrogen should be applied at 70 to 100 pounds per acre per year for maximum economic returns. Nitrogen applications should be split by applying half at green-up in May and the rest in early July.
- Sorghum-sudangrass and pearlmillet should be harvested each time growth accumulates to a height of 24 to 36 inches, leaving 10 inches of stubble for regrowth.
- Crabgrass should be grazed before it reaches a height of 8 to 10 inches, leaving 3 inches of stubble for regrowth.
- When grazed, annual grasses are best used with a rotational grazing scheme that leaves sufficient stubble and allows adequate rest between grazing periods to support regrowth.
- Forage should not be harvested or grazed following prolonged periods of drought or cloudy weather, particularly when heavily fertilized with nitrogen, without prior testing for nitrate content. Forage containing more than 1.5 percent nitrate should not be fed. Consumption of forages containing greater than 0.5 percent, or 5,000 ppm, nitrate should be limited to no more than one-fourth of the ration.
- After frost damage or drought stress, sorghum-sudangrass should not be grazed for 14 days or until there is 24 inches of regrowth. This helps to avoid prussic acid poisoning. Prussic acid dissipates during hay curing or ensiling, so forage harvested at the proper height or stored 10 to 14 days should not present a problem.