UNIVERSITY OF FLORIDA
IFAS EXTENSION

AE44

Grain sorghum: Harvesting, Drying and Storage [1]

Michael Talbot[2]

Grain sorghum has some characteristics that make harvesting, drying and storing it quite different from harvesting, drying and storing other Florida grain crops. But with some equipment modifications and good management, the machinery used to harvest, dry and store other grains can be effectively used for grain sorghum.

Harvesting

Excessive harvesting losses are common in grain sorghum. Header losses are often high, especially when lodging is a problem. The keys to low-loss harvesting of grain sorghum are harvesting at the right time, and doing it with properly operated equipment.

When to Harvest

Grain sorghum should be harvested as early as possible to minimize high combining losses, and losses to birds, insects, mold, and bad weather. In the Southeast, grain sorghum does not normally get dry enough in the field for safe storage until after a killing frost; but waiting for a frost increases the probability of excessive field losses. You should plan to harvest sorghum before it reaches safe storage moisture level and dry it mechanically.

Mature grain sorghum in the field contains about 30 percent moisture. At moisture levels higher than 25 percent, the seeds are too soft to withstand the threshing action of combining. The ideal moisture content for harvesting grain sorghum is about 20 percent. At higher moisture content, more losses would be expected in the tailings. At lower moisture content, header losses would probably be higher. Approximate harvesting losses expected at various moisture levels are shown in Table 1 .

Harvesting Equipment

A properly adjusted and operated, conventional combine will thresh, separate and clean grain sorghum satisfactorily. But the combine must have special adjustments and proper operation to keep harvesting losses low.

Standing grain sorghum can be combined with a regular grain header. It should be cut as high as possible without skipping too many heads. Cutter bar guard extensions are helpful if heads droop.

As with soybeans, reel bat speed should only be about 25 percent faster than ground speed to avoid shatter losses. The reel should be set high enough to avoid catching under the heads and throwing them over. Wider reel bats may he needed if plant height varies greatly.

1. This document is AE44, one of a series of the Agricultural and Biological Engineering Department, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. Reviewed June 2003. Visit the EDIS Web Site at http://edis.ifas.ufl.edu.
2. Michael Talbot, assistant professor, Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida, Gainesville, 32611.

Gathering losses in a standing crop are usually less at 2.5 to 3 mph (4.0 to 4.8 km/h), but this speed may overload the rack and shoe. In such a case, it is best to maintain this speed but take a partial swath to prevent overloading.

If lodging is a problem, consider a row-crop attachment to help pick-up and intake of the crop. These fit in front of the grain header cutter bar and have gathering points, gathering chains, and kicker wheels, somewhat like a forage harvester head. Vertical finger cylinders and spiral gathering cones are also used in row-crop attachments. Lodging is less severe at row spacings of 30 inches (76.2 cm) or less than 38 to 40 inches (96.5 to 101.6 cm), because adjacent plants are more likely to support the heads of broken stalks.

Threshing - Cylinder and Concave Adjustments

The combine cylinder and concave should be set to separate the seed from the head without over-threshing. The cylinder speed should be less than for wheat, and some combine manufacturers recommend removing the concave bars. Concave clearance should be about 1/2 inch (1.3 cm) in front and about 3/16 inch (0.5 cm) at the rear. The combine instruction manual gives details for such adjustments.

Sorghum stems often catch and choke the straw walkers, causing inconvenience and lost time in cleaning. Straw walker covers, which contain smaller holes to stop the stems but pass the grain, are available for most combines.

Grain sorghum stalks are smaller and wetter at harvest than corn stalks and are more likely to be chopped up and delivered to the grain tank. Pieces of stalk returned to the cylinder in the tailings will be chopped even finer. Therefore, keep the chaffer extension closed enough to prevent this, even at the expense of losing some grain. You may want to cover the chaffer extension with sheet metal to keep stalks out of the return.

Inspect the sieves during harvesting to detect matting, since this will lead to excessive grain loss. The upper sieve should be set 1/2 to 2/3 open and the lower sieve 1/3 to 1/2 open. They should have just enough air to keep the layer "alive and floating" and not be overloaded by too high a ground speed.

Measuring Field Losses

Combining field losses of grain sorghum can be checked by the following procedure.

1. Determine *total loss* by counting kernels in a 10 square foot (1 square meter) area over the width of cut behind the machine. Approximately 17 kernels per square foot (183 kernels per square meter) represents a loss of 1 bushel per acre (0.1 cubic meter per hectare).

2. Determine *pre-harvest loss* by counting kernels in a 10 square foot (1 square meter) area before the combine enters it.

3. Determine *gathering unit loss* by backing the machine several feet and counting the kernels in a 10 square foot (1 square meter) area across the width of cut in the stubble ahead of the cutter bar and subtracting the pre-harvest loss.

4. Determine *threshing and separation* loss by subtracting pre-harvest and gathering unit losses from the total loss.

If gathering unit losses exceed 8 percent, or threshing and separation losses exceed 2 percent, changes in adjustments and/or operating techniques should be made to reduce losses.

Drying

Wet sorghum cannot be held as long as corn, although farmer experience from other states indicates that holding overnight is not as dangerous as was thought. The sorghum mass packs tighter, allowing less air circulation and encouraging seed germination and mold growth.

To minimize wet holding risks, follow these pointers:

- Be very cautious about holding for more than one day ahead of the dryer, especially in your first year of experience. Also, be sure that all wet grain has been removed from the holding bin before refilling.

- Recognize that conditions of 23 to 24 percent moisture and 80° to 90°F (26.7° to 32.2°C) grain temperatures are ideal for heating, mold and sprouting. Safety margins are very narrow.

- Consider adding aeration of 1/2 cfm/bu (6.7 x 10^{-2} $m^3/s/m^3$)[1] to the wet holding tank.

Removing Trash

Trash and green matter contamination is more severe in drying sorghum than in drying corn. Most Southeastern sorghum is harvested before frost and usually there are many pieces of green stems and leaves to contend with. In the dryer, this trash tends to float and collect in corners, causing a fire hazard and affecting air flow.

Very trashy sorghum may need to be cleaned both before and after drying. Removing trash before drying decreases the load on the dryer and allows more uniform drying. However, "wet side" cleaning is difficult because the grain tends to be wet and sticky from stem juices released during combining.

Cleaning sorghum is a scalping operation to sieve out the large particles and trash rather than sifting out the fines from the seeds. If rotary screens are used, remember that the grain falls through the screen and the trash is retained. Since most cleaners are designed to retain the grain and drop the fines, the take-away conveyors may need to be reoriented to handle the large volume that falls through the screen.

Air Flow Characteristics

Since sorghum seeds are smaller than corn kernels, there is less space between them causing more resistance to air flow. At an air flow rate of 10 cfm/bu (1.34 x 10^{-1} $m^3/s/m^3$), a 3-foot (0.91 m) depth of sorghum has as much resistance as a 4-foot (1.22 m) depth of corn (Table 2).

Table 2 should not be interpreted to mean that you cannot dry sorghum at depths greater than 4 feet (1.22 in). Resistance to air flow depends on how much air you are forcing through the openings around the kernels or grains. By reducing air flow rates to 3 to 5 cfm/bu (4.02 to 6.70 x 10^{-2} $m^7/s/m^2$) (typical for deep bin drying), resistance (static pressure) will likewise be reduced to tolerable levels. This means, however, that both drying and cooling times will be longer than for corn.

Drying and Cooling Rates

An individual sorghum seed exposed to air flow will dry faster than a kernel of corn because it is smaller and the interior moisture can get out faster. But the greater flow resistance of a layer of sorghum in a bin reduces the quantity of air flow for a given static pressure. As a result, both the drying and cooling rates will be 2/3 to 3/4 that of corn under the same drying conditions, that is, grain depth and air temperature. Bin dryers which are capable of removing 10 points corn, in 24 hours, would be capable of drying sorghum about two-thirds as deep as the corn in the same period of time.

In column-type dryers, either batch or continuous flow, the grain layer thickness cannot be reduced as in a bin batch dryer. In this situation, a longer drying time is required. The discharge rate from continuous flow dryers needs to be reduced allowing grain sorghum to be exposed for a greater period of time to the drying air.

Fire Risk

Reports indicate that incidence of fire is greater when drying sorghum than when drying corn. One reason is that there is usually more trash with sorghum grain that can accumulate in pockets which stay in the dryer or block grain flow. Since this trash dries faster than the grain and may remain through several drying cycles, it can easily reach a "tinder condition." Another reason for dryer fires is that an inexperienced operator, in order to compensate for sorghum's slower drying rate, may increase the heat to hasten the drying process.

To minimize fire risk from igniting trash, the dryer, especially flow-through types such as automatic batch or continuous flow units, should be inspected (at least once a day) to make sure all pockets of material are unloading. Continuous flow dryers may have to be emptied daily to permit inspection. DO NOT leave fully automatic dryers running unattended for long periods of time. In fact, closely supervise all drying processes, especially if this is your first experience with sorghum drying.

Fuzz and fibrous dust tends to accumulate on and around motors, controls and equipment. This material collects moisture and can short-circuit motors and controls, or it may be ignited from normal arcing of the electric current when contacts open and close. Therefore, clean daily (preferably with compressed air) any dust accumulation on (a) end bell housing on open electric motors, (b) switch and control boxes, and (c) air intake screen on motors, radiators, filters and fans.

Many dryer fires apparently result from trash which is sucked into the intake, through the flame, then deposited, still glowing, in the plenum chamber and possibly in the grain mass. To prevent this, try to keep the ground clean around the air intake.

The intake may also be shielded to reduce ground pick-up. But do not restrict air flow by using too fine a screen (1/4-inch (0.6 cm) mesh is adequate), by reducing intake area or by sharp corners. Arrange the screen so that leaves and trash will drop away without blocking the air intake and be careful that overhead intakes do not pull in trash carried by wind gusts.

Recognize that trash can sift through and blow under false floors in bin dryers, making fire hazards as great as with flow-through dryers. The low position of the air intake of bin dryers presents an added trash pick-up hazard.

Drying Procedures

Any drying method used for shelled corn should also work for sorghum, subject to the limitations of lower air flow and, hence, capacity. Bin drying should be similar to corn if drying depths and layers are reduced 25 to 40 percent.

Corn and sorghum can be layered or mixed if the grain is to be used for livestock feed. Either can be placed on the bottom, but the overall depth or layer thickness should be reduced to compensate for the added flow resistance of the sorghum portion of the total.

Drying air temperatures are essentially the same for sorghum as for corn.

- 110°F (43.3°C) maximum for grain to be used for seed.
- 120° to 140°F (48.9 to 60.0°C) for non-stirred, batch-in-bin, feed-grain installations using air flows of 10 to 25 cfm/bu (1.34 to 3.35 x 10^{-1} $m^3/s/m^3$) for 2 1/2- to 4-foot (0.76 to 1.22 m) depths.
- 160° to 200°F (71.1 to 93.3°C) for feed grain in batch or continuous flow installations using air flows of 100 to 200 cfm/bu (1.34 to 2.68 $m^3/s/m^3$).
- Add 10° to 20°F (5.6 to 11.2°C) to outside air for deep layer drying with supplemental heat with timer or humidistat heat input control.

Procedures used for dryeration, grain stirring and blending can be the same as for corn if allowance is made for the increased air flow resistance of sorghum.

Grain sorghum must be dry to preserve its quality in storage. The moisture level to which it is dried depends on temperature during the storage period. Use Table 3 as a general guide to arrive at a storage moisture content.

Grain will dry to moisture contents which are stable or are in equilibrium with the air surrounding the individual kernels. Knowing when to operate the fans depends on these equilibrium conditions. Equilibrium moisture contents depend on temperature and relative humidity as illustrated in Table 4 .

Storage

Dry sorghum stores essentially the same as shelled corn. As mentioned above, it should be cleaned before storing. In addition, it should be mechanically spread or filled to distribute the fines and trash or the center should be withdrawn after filling to remove any concentration of fines.

Storage Tips

1. Employ preharvest preventive management practices to ensure proper grain bin sanitation and insect control.
2. Do not dry grain to a moisture content below that required for safe storage. The extra drying takes longer and costs more and the extra water

removed from the grain could have been sold at the price of grain.

3. Aerate grain to help maintain quality in storage. Aeration is low-volume ventilation (about 1/4 c.f.m. per bushel) to maintain uniform temperature throughout a grain mass, and to prevent moisture migration.

4. Monitor grain during storage to head off storage problems. Check every week or two for musty or spoiled odors, crusting, moisture condensation, elevated temperature, insects, rodents, etc.

Safety

Grain drying and handling can be dangerous. Transport augers can hit power lines, unguarded augers can catch hands or feet and fans and shafts can catch unsuspecting victims.

A deadly hazard exists for anyone in a grain bin when the unloading auger is started. Deaths occur every year from suffocation and injuries caused by unloading augers. Many of these victims are children.

Disconnect power to the unloading auger before entering bins. A knotted safety rope hanging near the center of the bin offers great protection. Have a second person standing by who can offer assistance and summon help.

Sometimes air pockets form when grain bridges over unloading augers due to spoiled grain or moisture. Never walk on this crusted surface, the pocket can collapse leaving a big hole.

Wear an effective dust mask when exposed to grain dust. Avoid breathing dust from moldy or spoiled grain.

When children are present on the farm, never engage any machinery before checking on the possible presence of a child.

Table 1.

Table 1. Expected Grain Sorghum Harvest Losses	
Moisture (%)	Losses (%)
30	11.2
20	8.7
16	16.3

Table 2.

Table 2. Static Pressure for Various Depths of Corn and Sorghum with 10 cfm/bu (1.34 x 10^{-1} $m^3/s/m^3$) Air Flow		
Grain Depth	Resistance to Air Flow	
	Corn	Sorghum
feet (meters)	inches of water (pascal)	
2 (0.61)	0.55 (136.86)	0.95 (236.4)
2.5 (0.76)	0.8 (199.07)	1.65 (410.59)
3 (0.91)	1.25 (311.05)	2.6 (646.98)
3.5 (1.07)	1.7 (423.03)	4.0 (995.36)
4 (1.22)	2.8 (696.75)	-
1. Cubic meters per second per cubic meters of grain		

Table 3.

Table 3. Guide to arrive at a storage moisture content	
Winter months(temperature below 60°F, 15.6°C)	13% or lower moisture content

Table 3.

Spring months(temperature range 60¡ to 80¡F, 15.6¡ to 26.7¡C)	12% or lower moisture content
Long term (temperatures sometimes above 80¡F, 26.7¡C)	11% or lower moisture content

Table 4.

Table 4. Grain Sorghum Equilibrium Moisture Contents

¡F(¡C)	Temp	Relative Humidity							
	10	20	30	40	50	60	70	80	90
60 (15.6)		7.5	9.5	10.7	11.8	12.9	14.0	15.5	
77 (25.0)	4.4	7.3	8.6	9.8	11.0	12.0	13.8	15.8	18.8
90 (32.2)		7.0	8.7	10.2	11.8	12.2	13.1	14.8	
120 (48.9)		6.6	8.0	9.4	10.7	11.6	12.7	14.3	

For example, at 77 ¡(25 ¡C) and 40% relative humidity, the equilibrium moisture content for grain sorghum is 9.8%.