PB 1912-J

TENNESSEE SOYBEAN PRODUCTION HANDBOOK

CHAPTER 10:

Harvesting, Drying, Handling and Storing Soybeans

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Soybeans have characteristics that differ significantly from other grain and oil seed crops. A softer seed coat allows soybeans to lose and gain moisture more rapidly. The seed coat is less durable than other grains, making them more vulnerable to cracking and splitting during drying, storage and handling. It is also a crop with a higher value per bushel, which makes the risk from loss more serious economically. Harvesting, handling, drying and storing soybeans safely are some of the final steps for producers each year. Often these steps occur within a relatively short period, which can require some very quick decisions should any problems be encountered. To maximize yields and profitability, sound management decisions must occur during this timeframe.

HARVESTING

Soybeans can be harvested when the seed moisture content ranges from 9 to 20 percent (wet basis). In general, soybeans harvested at or above 15 percent seed moisture have much less seed damage than when harvested at lower moisture levels. Cracked and damaged seed typically increases as seed moisture content decreases from about 13.5 to 9 percent. An additional concern is that once seeds dry down to harvestable moisture contents and rewetting occurs, the percentage of cracked and damaged seeds increases when harvested. Most producers in Tennessee harvest between 13.5 and 15 percent seed moisture to capture the greatest amount of undamaged seed and minimize drying costs.

OPERATING THE COMBINE

When harvesting soybeans, the most important combine adjustments, in order of importance, are 1) ground speed, 2) cutterbar height, 3) reel position and speed, and 4) cylinder speed. Ground speed should be maintained between 2.5 and 4 mph to reduce losses at the header. The cutterbar should be as low as possible for field conditions to minimize leaving pods at the bottom of the plant. The reel axle should be 6 to 12 inches in front of the cutterbar and run about 1.25 times faster than the ground speed to reduce shattering. Finally, the cylinder speed should be below 500 rpm to reduce cracking and damage to the seed. Initial settings for the cylinder speed and concave/rotor spacing should always follow the operator's manual.

HARVEST LOSSES

An average operator is estimated to leave from 3 to 5.5 bushels of soybeans per acre in the field (5 to 10 percent loss, assuming yields of 55 bu/A). Measure harvest losses for each field by counting seed on the ground. Count the number of seeds on the ground in front of the combine to determine pre-harvest losses. Then count the number of seeds behind the combine to measure total loss (pre-harvest and harvest loss). About 4 seeds per square foot represents 1 bu/A loss. A good goal is to limit harvest loss to less than 3 bu/A or about 12 seeds per square foot. Inspect the soybean stubble to ensure that all pods were harvested. To reduce harvest losses, adjust ground speed, cutterbar height (if pods remain on standing stubble), reel speed and position, and cylinder speed. Inspect cutterbars for sharp knives and replace as necessary.

HANDLING

Handle the soybeans as little and as gently as possible because the seedcoat is easily cracked. Damage to soybeans is more severe when conveyed at moisture contents below 12 percent; however, the most important factors to consider when conveying soybeans by augers are the fullness and speed of the auger. Augers should be run as full as possible and at low speeds. To keep an auger full, you must maintain a reservoir of grain above the inlet of the auger. More power is required to run the auger when it is full, so make sure the power unit is sufficient to handle the workload. Auger output is related to its speed and diameter, so, for a larger system capacity, a larger diameter auger will sometimes be required if the speed is kept low.

CLEAN GRAIN

Excessive trash should be removed from soybeans before they are stored. Accumulation of trash in small pockets in a grain bin can cause heating and decay, which may lead to elevator discounts. Cleaning soybeans normally requires removing particles that are larger than the seed. Bins should also be cored after filling to remove fine material from the center and provide more uniform airflow.

DRYING

Mature soybeans left exposed to rain or damp weather develop a dark brown color and a mealy or chalky texture that will lower the grade. Seed quality deteriorates rapidly with increased weather exposure. Drying of soybeans has usually been necessary only when inclement weather has occurred during the harvest period.

Soybeans are usually dried in the field or in a bin with either natural air (no heat) or with a small amount of heat (5 to 10 F) when the relative humidity of the air is above 80 percent (***Table 10-1***). Generally, a drying temperature below 110 F is recommended. Drying time is dictated by airflow rate, with a minimum of 1 cubic foot per minute per bushel (cfm/bu) recommended for in-bin drying. The University of Minnesota Extension Service website[1] can be used to estimate the airflow rate for a given fan-bin combination. For example, a 10 horsepower (hp) axial fan can provide 1 cfm/bu in a 30-ft diameter bin of soybeans that is 20 feet deep (11,300 bu), or 3 cfm/bu at 8 feet of depth (4,500 bu).

Refer to the equilibrium chart (***Table 10-1***) as a guide for the limits of drying at the average temperature (T) and relative humidity (RH) levels shown. For example, during October the average ambient T and RH in Tennessee are 60 F and 70 percent, respectively, so soybeans will dry to about 13.8 percent moisture content. If left in the field until November when the average T and RH are 50 F and 70 percent, soybean moisture content will be about 14 percent. Adding just 5 degrees of heat in a bin dryer lowers the RH to 65 percent and the corresponding moisture to around 12 percent. Be careful not to over-dry soybeans by running fans when the RH is below 60 percent.

STORAGE

Soybeans should be stored at 13 percent moisture content (wet basis) or less, depending on the temperature of the grain during storage and the length of time the crop will be held. If soybeans are to be stored over the summer months, the moisture content should be about 12 percent to eliminate the possibility of spoilage in storage.

AERATION

Soybeans stored in bins can spoil even if they are dried to the recommended storage moisture content. The most frequent cause of pockets of spoiled grain in storage is moisture migration, a phenomenon by which dry grain will re-wet and spoil. Bulk grain actually contains 35-40 percent of air so is a good insulator. For this reason, soybeans near the center of the bin tend to maintain the temperature at which they came from the dryer or field. Soybeans near the bin wall tend to cool to near the average outside temperature. The heavier cool air next to the bin wall becomes denser and falls to the bottom of the bin, which forces warmer air up through the center of the bin. As this moist air passes through the center, it warms and picks up more moisture (***Figure 10-1***). When this warm air comes in contact with cool grain near the top surface, it drops its water (or condenses, much like condensation on cold windows) and causes a pocket of higher moisture grain at the top center of the stored grain. Crusting is an indication of moisture accumulation and mold growth. The reverse situation occurs during the summer months. In this case, the moisture condenses near the bottom center of the grain mass.

Moisture migration can be prevented by aeration. Aeration equalizes temperatures within stored grain and prevents

[1] See the University of Minnesota Department of Bioproducts and Biosystems Engineering webpage on fan selection: https://bbefans.cfans.umn.edu

Table 10-1. *Equilibrium moisture content (% wb) for soybeans at various temperature and relative humidity levels.*

TEMPERATURE F	PERCENT RELATIVE HUMIDITY						
	40	50	60	65	70	80	85
30	7.9	9.5	11.6	12.9	14.5	19.2	23.1
40	7.7	9.3	11.4	12.7	14.3	18.9	22.7
50	7.6	9.1	11.2	12.4	14.0	18.6	22.4
60	7.5	9.0	11.0	12.2	13.8	18.3	22.0
70	7.3	8.8	10.8	12.0	13.5	18.0	21.7
80	7.2	8.7	10.6	11.8	13.3	17.7	21.3

Source: ASABE, 2009.

these air currents from forming. A minimum airflow rate of 1/10 cfm per bushel is recommended and the University of Minnesota WINFANS program can be used to determine fan capacities at different grain depths for each fan-bin combination. Grain should be cooled once a month by 10 F until it has been cooled to 35 to 40 F. Estimate the time needed for aeration by dividing 15 by the airflow rate in cfm/bu. For example, at 0.1 cfm/bu it will take about 150 hours to move a cooling front through the grain; however, only 15 hours are required at 1 cfm/bu.

MONITORING

Soybeans are the most valued crop held in storage, so bins should be checked regularly to detect potential spoilage problems early before they grow/expand to large problems. Failing to monitor grain conditions throughout the entire storage period is a mistake that can lead to elevator discounts or (worst case) rejection. Regular inspections are essential to preserve crop value and detect heating and/or elevated levels of carbon dioxide (CO_2) from mold and insect activity. How often you need to check soybeans in storage will depend on the time of year, the initial condition of the crop when harvested and how often the grain is aerated. Generally, soybeans should be inspected at least once a month during the winter and every two weeks during the spring, summer and fall. When checking bins, look for:

- Condensation on the grain surface, crusting, wet areas, molds and insects
- Leaks or condensation on the bin roof
- Non-uniform temperatures in the grain mass (more than 10 F), pockets or layers of high-moisture grain, elevated CO_2 levels
- Musty or sour odors. Generally, if you can smell a musty odor, a grain spoilage problem is already well underway. By monitoring CO_2 levels weekly, off-odors can be controlled.

Any problems that are found need to be evaluated and corrected as soon as possible. This may include running the aeration fan(s); moving the grain out of the bin, through a cleaner and into another bin; further drying; and/or fumigation for insect control.

SAFETY

Flowing grain is dangerous and can be fatal. Educate all workers on the farm of the hazards associated with flowing grain and exposure to grain dust. Never enter a grain bin while the unloading auger is operating because the downward flow can pull a person below the grain surface in less than five seconds and result in suffocation. Always lock-out-tag-out the power to electrical motors on unloading augers prior to entry. Work in pairs with a person on the ground who can call for help if needed. Personal protective equipment for bin inspections includes a climbing harness with a properly anchored tie-off rope and respirator at minimum.

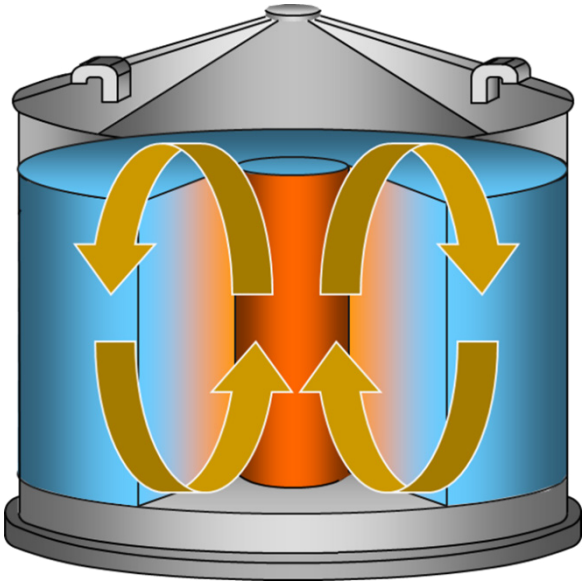

Fig. 10-1. *Winter moisture migration.*

REFERENCES AND RESOURCES

ASABE. 2009. "Moisture relationships of plant-based agricultural products." D245.6. ASABE Standards. St. Joseph, MI.

Buschermohle, M. J., L. O. Pordesimo, and L. R. Wilhelm. 2005. "Maintaining Quality in On-Farm Stored Grain." UT Extension, PB 1724. https://extension.tennessee.edu/publications/documents/PB1724.pdf

Buschermohle, M. J., and S. G. McNeill. 1997. "Drying, Handling and Storing." In: Soybean Production in Tennessee. UT Extension, PB 1608. https://extension.tennessee.edu/publications/Documents/PB1608.pdf

Hamilton, H. E., O. J. Loewer, Jr., and D. G. Overhults. 1973. "Harvesting, Drying and Storing Soybeans." University of Kentucky CES AEN-25. Archived.

Helsel, Z. R. and H. C. Minor. 1993. "Soybean Production in Missouri." University of Missouri Extension Service. https://extension.missouri.edu/publications/g4410

Hurburgh, C. R. 2008. "Soybean Drying and Storage." Iowa State University Extension, PM 1636. https://store.extension.iastate.edu/product/5141

Maier, D., S. J. McNeill, and K. Hellevang. 2017. Grain Drying, Handling and Storage Handbook. Midwest Plan Service, Ames, IA. https://www.mwps.iastate.edu/catalog/grain-handling-storage/grain-drying-handling-and-storage-handbook

Overhults, D. G., G. M. White, H. E. Hamilton, and I. J. Ross. 1973. "Drying Soybeans with Heated Air." Transactions of the ASAE 16(1): 112-113. doi.10.13031/2013.37459

Overhults, D. G., G. M. White, H. E. Hamilton, I. J. Ross, and J. D. Fox. 1975. "Effect of Heated Air Drying on Soybean Oil Quality." Transactions of the ASAE 18(5): 942-945. doi.10.13031/2013.36713

University of Minnesota Department of Bioproducts and Biosystems Engineering. 2022. "University of Minnesota Fan Selection for Grain Bins." https://bbefans.cfans.umn.edu

Wills, J. B. 1997. "Combining Soybeans Efficiently." In: Soybean Production in Tennessee. UT Extension, 1608. https://extension.tennessee.edu/publications/Documents/PB1608.pdf

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