



Cooperative Extension Service The University of Georgia College of Agricultural and Environmental Sciences

HARVESTING, DRYING AND STORAGE SOYBEANS

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Producing a high-quality soybean crop is one thing. Harvesting those soybeans with minimum losses and then drying and storing them in a way that maintains quality until the soybeans are marketed is another. A reduction in harvest losses of three bushels per acre when harvesting three acres per hour can result in a savings of \$54 per harvesting hour based on \$6 per bushel. Proper drying and storage will maintain quality soybeans and assure minimum losses.

Harvesting

Harvesting Losses

The grain-combine harvester has been used for soybeans since the mid-twenties but little progress was made in reducing harvesting losses until about 1970. Until then, the average combine using a rigid grain platform header resulted in as much as 10 percent losses during the harvesting operation. The introduction of attachments such as the floating cutter bar and pick-up reel reduced harvesting losses to 7 or 8 percent. More recently combine headers that have a built-in, flexible cutterbar have been designed and developed specifically for use in soybeans. A low profile, row-crop header was introduced by John Deere and Company in 1974. Harvesting losses can be reduced to about four percent of yield with these new headers.

The types of harvesting losses should be identified and measured so that proper combine adjustments can be made to increase soybean harvesting efficiency.

Preharvest losses are those that occur from natural causes before harvest. These losses result from soybeans that have fallen to the ground by the time harvest begins. If soybeans that are ready for harvest are subjected to several alternating periods of wet and dry weather, preharvest losses could be as high as 25 percent.

Gathering or header losses are soybeans that are not gathered into the combine. These losses are caused by the action of the cutter bar, reel and auger

and account for more than 85 percent of the total soybean losses at harvest. There are four kinds of gathering losses. **Shatter losses** are shelled soybeans and detached soybean pods that are shattered from stalks by the header. **Stubble losses** are soybeans in pods remaining on the stubble because of operating the cutterbar too high, etc. **Stalk losses** are soybeans remaining in pods attached to stalks that were cut but not delivered into the combine. **Lodged losses** are soybeans remaining in pods attached to stalks that were not cut or that were cut at heights greater than that of the stubble.

Soybeans are easy to thresh, separate and clean. Soybeans can be rubbed out of the pod readily and their size and shape are ideal for cleaning. Even so, small errors in the adjustment of the combine can result in disastrous losses during the threshing, separating, and cleaning operations. **Threshing** or **cylinder losses** occur when shelled soybeans are carried out the back of the machine with the stalks. Separating losses are usually insignificant unless the combine is overloaded. **Cleaning** or **shoe losses** occur when shelled soybeans are carried over the chaffer or top sieve and out the back of the combine.

Measuring Losses

Harvesting losses can be measured by enclosing a ten square foot area with a rectangular frame and counting the soybeans remaining in that area after harvest. A count of 40 beans within the frame represents approximately one bushel per acre. Make the frame from heavy cord or cloth line so it can be coiled and carried on the combine. The length of the frame should be equal to the cutting width of the combine header (see table below). Make four pins 3 to 4 inches long from No. 9 wire and tie them to the frame to mark the corners. The pins should be pushed into the ground to hold the frame tight.

FRAME WIDTH BASED ON COMBINE HEADER WIDTH.

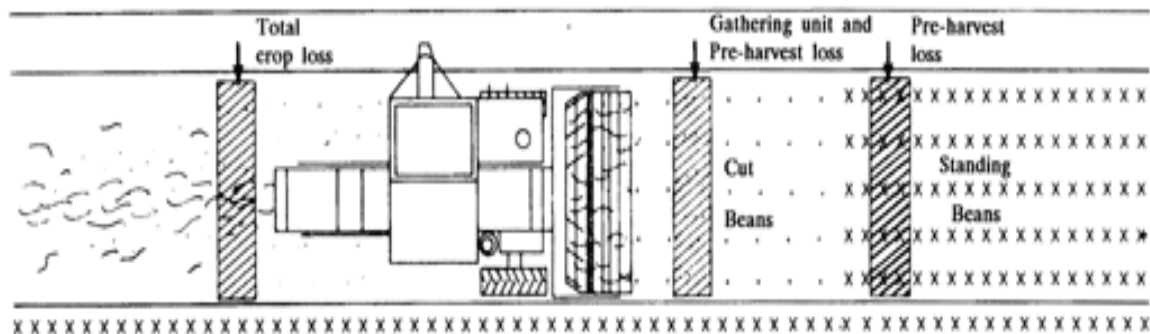
Header width (feet)	Frame width (inches)
16	7 1/2
18	6 3/4
20	6
22	5 1/2
24	5

The procedure for determining field losses can be seen in the figure below. Operating the combine in the normal way, move into the crop until well away from the edge of the field. Then, the combine should be stopped, the platform drive disengaged, the platform raised and the combine backed up 15 to 20 feet. In measuring total losses the frame should be placed across the harvested rows behind the combine and the loose soybeans, soybeans in pods on or off the stalks and soybeans on the stubble inside the frame should be counted. This

figure divided by 40 represents an estimate of the losses in bushels per acre, and it includes both preharvest and harvest losses. If the loss is near three percent of the yield, continue harvesting.

To measure preharvest losses, the frame should be placed across the rows of standing soybeans in front of the combine and loose soybeans and soybeans in pods on the ground should be counted and divided by 40. To determine the total harvesting losses the preharvest losses should be subtracted from the total losses found behind the combine.

The shaded areas indicate frame placement for measuring total soybean loss, preharvested loss, and gathering loss.



Reducing Losses

Preharvest losses can be minimized by planting shatter-resistant varieties and early harvest. Soybeans should be harvested shortly after their moisture content first reaches 14-16 percent.

Header designs play an important role in reducing harvesting losses. The row-crop header has proven to be more efficient than platform type headers. Of the platform type headers, the flexible floating cutterbar header is the most efficient but slightly less efficient than the row-crop header.

The flexible floating cutterbar header has several features that enable it to reduce soybean losses: its long dividing points help prevent problems that occur in lodged soybeans; its extended platform and low profile reduce shatter and stalk losses; and its large-diameter auger rapidly moves plant material to the center and helps reduce stalk losses.

To take full advantage of the time available for harvesting, make all necessary repairs and major adjustments well before the harvest season. The combine should be thoroughly repaired, lubricated and adjusted as instructed in the operator's manual. Reduction in gathering losses can be accomplished only if the header is adjusted to cut close to the ground to avoid leaving soybeans on the stubble and shattering them from the stalks. To further reduce shatter losses, set

the header to handle the soybeans as gently as possible. Rough handling by the header's cross auger and by the slat conveyors in the feeder housing can thresh a substantial percentage of the soybeans before they reach the combine cylinder. These soybeans can be lost if the slope of the header's deck is improperly adjusted, the deck is not tight, or if the plant material is not fed uniformly into the combine cylinder.

Almost all gathering losses are caused by the action of the knife and reel. The knife must be kept sharp and broken or badly worn sections replaced. Plates should be adjusted to minimize knife vibration. The guards should be aligned and the knife clips adjusted so the knife can move freely and cut efficiently.

Proper reel adjustments are particularly necessary to keep losses low. If the reel turns too fast, it will shatter soybeans excessively. If the reel turns too slowly, it may drop stalks or allow them to be recut. A pick-up reel can help reduce harvesting losses. The speed of the pick-up reel should be 50 percent greater than ground speed. A 42-inch reel should rotate at about 12 revolutions per minute (rpm) for each 1 mph of forward speed.

The reel axle should be eight to 12 inches ahead of the sickle on most headers. With a pick-up reel and floating cutter bar, the reel axle should be about eight inches ahead of the sickle. Several manufacturers are now providing headers with a built-in, flexible cutter bar. When harvesting short plant material, the reel axle should be moved nearer the cutter bar.

To prevent excessive threshing and separating losses and to still keep the soybeans clean, the threshing and separating mechanisms must be kept properly adjusted. The single most important item to check is the separator speed. In each combine a particular shaft serves as a starting point for checking the operation speed. In some machines this starting point is the cylinder beater cross-shaft; in others it is the primary counter shaft. Most combines are designed to operate at the proper speed when the speed control lever of the engine is in the maximum position. Adjustment is needed if the separator is not running at the proper speed with the control level in this position.

To determine the procedure for adjusting engine speed, the operator's manual should be used or adjustments should be made by a local dealer. A small deviation from the correct engine speed can affect the operation of the cleaning and separating units making it impossible to get soybeans clean and keep losses to a minimum.

Before taking the combine to the field, the cylinder speed, the cylinder-concave clearance, the sieve settings and the speed and opening of the cleaning fan should be adjusted. If the operator's manual is followed closely in making these adjustments, only minor adjustments should have to be made in the field.

The cylinder and fan speed must be adjusted to fit threshing conditions. When the moisture content of the soybeans is above 13 percent, they are usually tough; so the cylinder speed may have to be increased to 600 rpm. As soybeans dry, lower the cylinder speed to reduce breakage; 450 to 550 rpm should be high enough for soybeans that are below 13 percent in moisture content.

Drying and Storing Soybeans

Drying soybeans has two principal advantages. Drying permits harvesting the grain as soon as it is ripe and mature to avoid field losses and it places the grain in a condition for safe storage reducing storage losses from heat damage and molds. Drying is the universal method of conditioning wet grain to preserve its quality and nutritive value for feed and food and its germination for seed.

Soybeans should be harvested promptly when they are mature to reduce field losses and lessen chances of damage from bad weather. However, at this stage soybeans contain too much moisture for safe storage. With adequate **drying methods**, soybeans can be harvested at a moisture content as high as 20 percent.

However, when drying from 20 percent to a safe moisture content, a large amount of water must be removed increasing the cost of the drying operation. High moisture grain loses this moisture rapidly in the field; thus, for maximum returns soybeans should be harvested when they have reached approximately 14 to 16 percent moisture content.

The percent weight reduction when drying grain and soybeans can be easily estimated (see following).

PERCENT REDUCTIONS IN WEIGHT OF SOYBEANS FROM DRYING.

Original Moisture Content (%)	Final Moisture Content (%)					
	10	11	12	13	14	15
	-----Weight Reduction (%)-----					
16	6.7	5.6	4.5	3.4	2.3	1.2
17	7.8	6.7	5.7	4.6	3.5	2.3
18	8.9	7.9	6.9	5.8	4.7	3.6
19	10.1	9.0	8.0	6.9	5.8	4.7
20	11.0	10.1	9.0	8.1	7.0	5.8

For example, soybeans with an original moisture content of 16 percent dried to a final moisture content of 11 percent lose approximately 5.6 percent from the original weight. On 1,000 pounds of soybeans (original weight), the loss would be 56 pounds and the final dried weight, 944 pounds.

The recommended maximum moisture content for one year of safe storage of soybeans in Georgia is 11 percent in north Georgia and 10 percent below the fall line. Note that this is the maximum moisture content to be found anywhere in the storage bin and is not the average for all the beans in the bin.

The two principal factors involved in the safe storage of soybeans are moisture content and temperature. The amount of moisture in soybeans determines whether or not mold damage will occur. The higher the moisture and the temperature, the faster the mold growth and the more rapid the spoilage of soybeans. Insect damage is also less in dry, stored soybeans.

Low temperatures offset the effects of high moisture, particularly as it affects the development of molds and insects. Cooling is one of the greatest benefits gained from moving and turning soybeans in elevators. This can be accomplished more effectively by aeration which cools soybeans so that damp soybeans can be held in storage for weeks or even months.

In all practical soybean drying systems, air is used as a medium for removing moisture as it is evaporated. Evaporation of the moisture requires heat energy that is normally supplied by the air forced through the soybeans. When dry air is forced up through a deep layer of wet soybeans, drying starts at the bottom where the air first enters. As the flow of air continues, more of the soybeans begin to dry, so that a layer known as the "drying zone" is formed. The drying zone continues to move upward through the wet soybeans until it is passed through the surface layer.

Relative humidity of the drying air determines the moisture to which grain will dry. At a given temperature and relative humidity, there is a corresponding moisture content below which the grain will dry no more. This property of grains is referred to as the "equilibrium moisture content".

EQUILIBRIUM MOISTURE CONTENT						
Relative Humidity (%)						
Air Temp. (F)	20	35	55	70	80	90
	-----Moisture Content (%)-----					
40	6.3	8.5	11.0	13.5	15.5	19.5
60	5.8	8.0	10.0	12.0	14.0	17.5
80	4.5	7.0	9.0	11.0	13.0	15.8
100	4.0	6.0	8.2	10.3	12.2	14.5

The safe maximum temperature of the heated air for drying any grain is determined by the final use of the grain. For soybeans to be milled for oil and those to be used for food, the temperatures in heated-air batch driers should be

limited to 130F. Soybeans to be used for seed should not be exposed to air over 110F.

For in-storage drying, temperatures of the drying air over 100F are seldom encountered. However, the initial moisture content and the time of exposure of the wet grain to this higher temperature above the drying zone become important factors. The greater the moisture content of the soybeans, the greater the air flow required per bushel to dry it to a safe moisture content before mold attach can set in.

Stored soybeans should be **aerated** to keep them at a cool, uniform temperature. If stored in bins equipped for drying, all the soybeans can be cooled to a uniform temperature in about 10 to 15 hours. The soybeans should be cooled immediately after drying is completed and the cooling repeated every two months during the winter and once in the spring on a cool, dry day. After each cooling, all openings to the plenum under the floor should be closed and a tight cover put over the fan inlet to prevent any outside air circulating through the grain. The air can be forced up through the grain as in drying, provided condensation does not occur on the bin roof. It is not always necessary to pull the air through the grain as in aerating grain with smaller fans, in which case pulling is essential. The purpose of aeration is to keep the grain at a uniform cool temperature which prevents "top sweating" in the top layer of grain in the center of the bin.

Mechanical injury to soybean seed should be avoided as it is an important cause of decline in germination and vigor. Injury to soybean seed results primarily from impacts of the seed with hard surfaces or other seed. The extent and severity of mechanical damage is related to the moisture content of the seed, the velocity of the seed at the moment of impact, and the degree of hardness of the impacted surface. A single 10-foot drop of seed with less than 12 percent moisture against a metal surface can reduce germination by as much as 10 to 15 percent. Seeds with 14 percent or more moisture are relatively unaffected by impacts resulting from drops as high as 20 feet.

Soybeans for use other than seed are also affected by dropping into a bin if moisture content is too low. A certain amount of splitting will occur each time they are dropped. Soybeans should be handled as little and gently as possible.

Safety

Good safety habits are a must for anyone who operates a modern combine or who is involved in soybean storage and hauling.

Always keep the combine clean because field trash around the exhaust system can cause fires. Before a combine is lubricated or adjusted or cleaned, all drives should be disengaged and the engine stopped.

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 as deaths occur every year from suffocation and injuries caused by unloading augers. Power to the unloading auger should be disconnected before entering bins. A knotted safety rope hanging near the center of the bin offers greater protection and a second person should be standing by, who can offer assistance. Air pockets sometimes form when grain bridges over unloading augers due to spoiled grain and moisture. This crusted surface should not be walked over because the pocket can collapse. Wear an effective dust mask when exposed to grain dust.

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