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Harvesting and Drying Soybeans

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SOYBEAN HARVESTING

Soybean production in the United States is more than a billion bushels per year with projections for a continued increase for several more years. Studies conducted in Illinois and other states reveal that the average combine operator leaves nearly 10 percent of his crop in the field. Field experience and research studies also reveal that these losses often can be reduced to 5 percent. An alert combine operator under some conditions can do even better. He can keep his losses to 4 percent of the crop, and possibly less. To get these low losses you need to know where harvesting losses occur, how to measure losses, what reasonable levels of losses are, and the machine attachments, adjustments, and operating practices that will help reduce losses if yours are too high.

WHERE HARVESTING LOSSES OCCUR

Losses in soybean harvesting can be divided into several major categories.

Preharvest Losses

Beans that are lost due to natural causes not related to the combine are called preharvest losses. Usually preharvest losses consist of beans that have dropped to the ground before harvest.

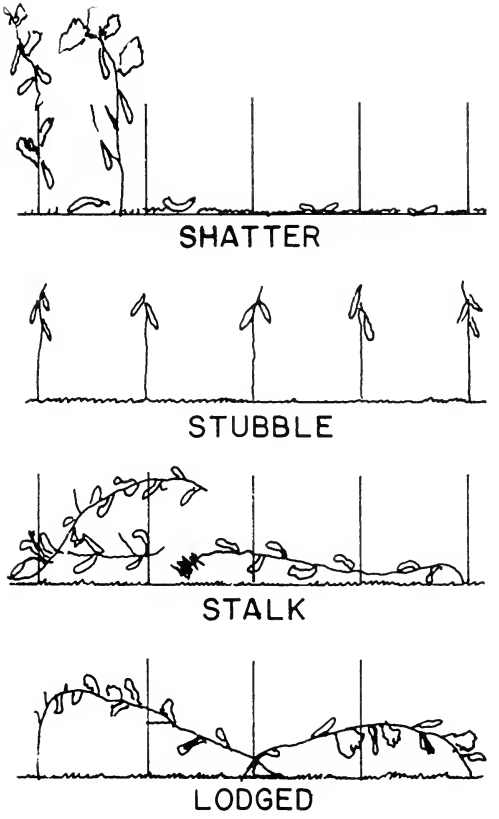
In most instances, preharvest losses are low if beans are harvested shortly after the beans reach a moisture content of 13 percent for the first time. However, if beans are ready for harvest and then are subjected to several alternating periods of wet and dry weather, preharvest losses can be as much as 25 percent, depending on variety. Preharvest losses are, therefore, influenced greatly by the time of harvest and can be reduced by harvesting early.

Gathering Losses

Gathering losses are those soybeans that are not gathered into the combine, less the preharvest losses.

Gathering or header losses account for more than 85 percent of the total losses in soybean harvesting. These include all losses occurring at the header and caused by actions of the cutterbar, reel, and auger, and those losses from soybeans left on uncut stubble. Gathering losses are further divided as follows.

Shatter losses — shelled beans and detached bean pods that are shattered from stalks by the header and fall to the ground without going through the combine.



The four types of gathering or header losses. (Fig. 1)

Stubble losses — beans remaining on stubble.

Stalk losses — beans remaining in pods attached to stalks which were cut but not delivered into the combine.

Lodged losses — beans remaining in pods attached to downed stalks which, if cut, were cut at lengths greater than the stubble height (Fig. 1).

Threshing, Separating, and Cleaning Losses

Soybeans are an easy crop to thresh, separate, and clean. They are easy to rub out of the pod and their size and shape is perfect for cleaning. However, small errors in adjustment can be disastrous, so close attention must be given to these losses which occur within the combine.

Threshing (cylinder) losses — unthreshed beans remaining in pods that pass through the combine and loss that occurs due to beans cracked by the cylinder.

Separating (straw walker) losses — shelled beans that are carried out the back of the machine with the stalks. These losses are usually insignificant unless the combine is overloaded.

Cleaning (shoe) losses — shelled beans that are carried over the chaffer (top) sieve and out the back of the machine.

WEED CONTROL IS ESSENTIAL

Weedy soybean fields produce a double penalty. Competition from weeds can cut yields by as much as 30 percent. Weeds such as pigweed, velvetleaf, smartweed, foxtail, and morning glory decrease harvesting efficiency.

Results from harvesting weedy soybeans have shown that weeds do not cause increased header losses during harvest provided the weeds are dry before harvest. However, threshing and separating losses increased when weedy soybeans were harvested before frost caused the weeds to dry. For example, before frost and with a combine speed of 3 m.p.h. the threshing and separating losses were 0.5 percent of the yield in weed-free soybeans, compared with 4.4 percent in pigweed-infested soybeans. By decreasing the combine speed to 2 m.p.h. the threshing and separating losses were decreased to 2.1 percent.

It is highly recommended that all reasonable means be used to control weeds in soybeans. If severe weedy conditions are encountered during harvest, especially when weeds are green, reduce travel speed to maintain low threshing and separating losses. Do not increase cylinder speed because this will only cause excessive damage to the beans and more trash in the grain tank.

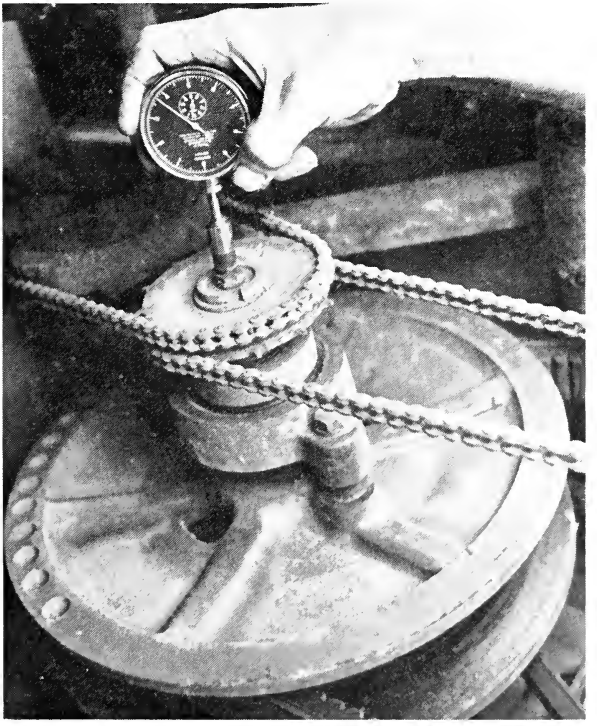
HAVE COMBINE READY AHEAD OF TIME

Depending on the weather, soybeans can dry rapidly. After reaching maturity, they can lose 5 moisture points per day until they reach the 15-percent moisture level. Then drying slows down somewhat, but the reduction can still be 1 to 2 moisture points per day. In wet, humid weather beans also absorb moisture rapidly. This changing moisture content of soybeans caused by weather conditions means harvest time is often too short. The period of time when soybeans can be harvested with minimum loss may be only a few days. Soybeans are usually harvested as soon as they reach 13 percent moisture. This moisture content is used because beans can be stored at 13 percent and because most local grain markets impose a dockage for beans exceeding 13 percent moisture. In some cases it may be desirable to harvest beans with moisture higher than 13 percent and then dry the beans before they are stored. It is important to complete the harvest as soon as possible once the beans are ready, because as beans dry out the harvesting losses increase rapidly.

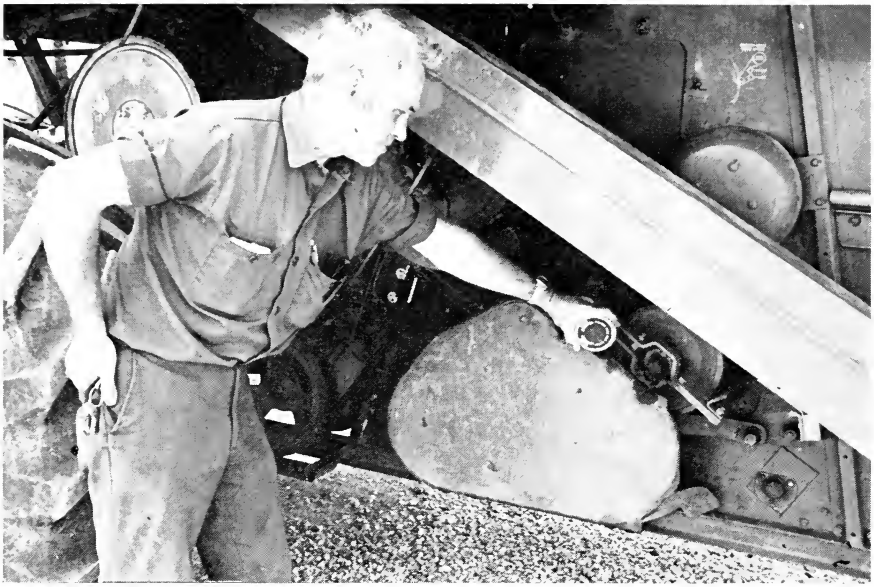
To take advantage of the time available for harvesting, make all the necessary repairs and major adjustments well before the harvest season. Use the operator's manual as a guide, and thoroughly repair, lubricate, and adjust the combine. Be as familiar as possible with the adjustments in the manual and those listed below in this publication so corrections can be made easily and quickly in the field.

COMBINE ADJUSTMENTS

Probably the most important single item to check is the separator speed. Each combine has one particular shaft as the starting point for checking operating speed (Fig. 2). Some machines use the cylinder beater cross shaft, while others use the primary countershaft speed as the starting point. Most combines are designed to operate at the proper speed when the speed control lever of the engine is in the maximum speed position. If the separator is



Check the separator speed with a tachometer. If it is not running at the proper speed with the engine at full throttle (see instructions in operator's manual), then adjust the separator speed. (Fig. 2)



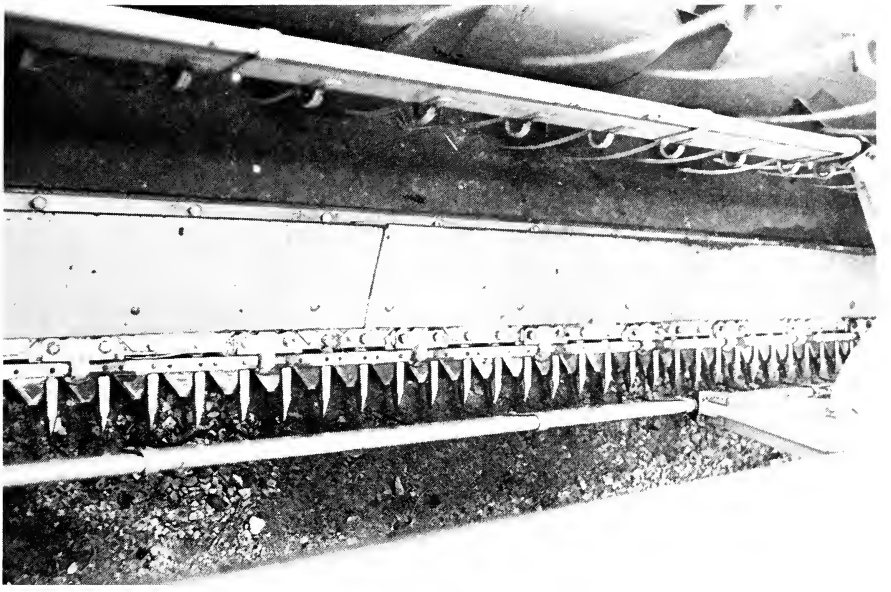
Adjust the fan speed to the crop and feed rate. The air blast from the fan should remove most of the chaff and straw from the soybeans. Adjust the fan for maximum usable air volume without blowing soybeans into the tailings or out the rear of the combine. (Fig. 3)

not running at the proper speed with the control lever in this position, adjustment is needed.

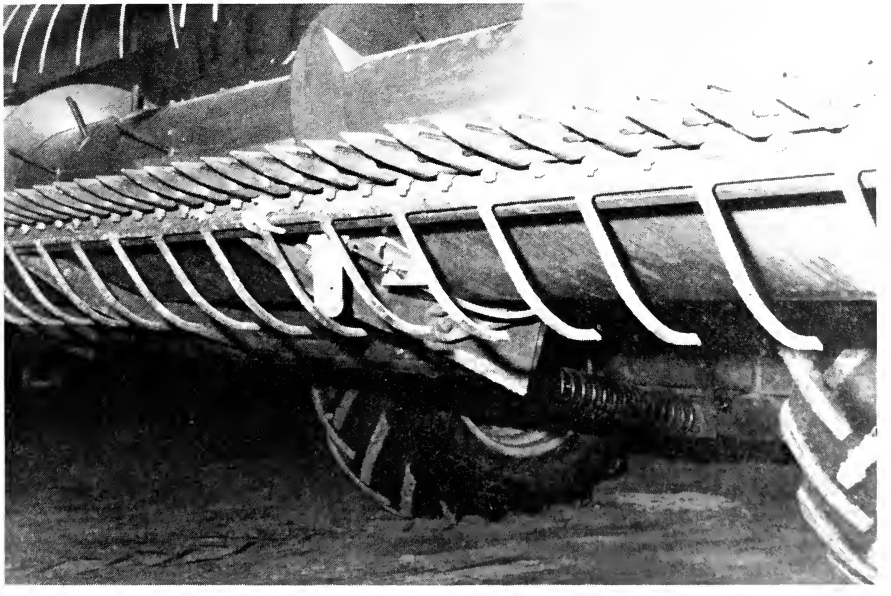
If you are not certain of the procedure for adjusting engine speed, have the work done by your local dealer. A small deviation from the correct engine speed can upset the operation of the cleaning and separating units, and you will find it impossible to get soybeans clean and keep losses to a minimum.

Before the combine goes to the field, there are a number of other adjustments that should be made, using the operator's manual as a guide. In addition to cylinder speed, these adjustments include cylinder-concave clearance, sieve settings, and fan adjustment for cleaning (Fig. 3). If the manual's recommendations are closely followed, the operator usually needs to make only minor adjustments in the field.

For most combines the recommended cylinder-concave clearance for soybeans is 3/16 to 5/16 inch at the back and ⅜ to 1 inch at the front. Cylinder speed must be adjusted for your threshing conditions. When beans are above 13 percent they are usually tough and cylinder speed may have to be increased to 700 to 750 r.p.m. As beans dry reduce cylinder speed to reduce breakage; 450 to 500 r.p.m. should be high enough for beans below 13 percent moisture.



A floating type cutter bar with header height control will help reduce soybean losses by decreasing the stubble height. (Fig. 4)



Automatic hydraulic header height control. (Fig. 5)

HEADER ADJUSTMENTS

Keep the header of your combine in good repair and adjustment. Proper reel adjustments are particularly important for low gathering losses. A pick-up reel should be used with a floating cutterbar (Fig. 4).

Speed of the pick-up reel should be 50 percent faster than ground speed for minimum gathering losses. A 42-inch reel should rotate at about 12 r.p.m. for each 1 m.p.h. of forward speed. The reel will shatter beans excessively if it turns too fast, and too many stalks may be dropped or recut if it turns too slowly.

The reel axle should be 8 to 12 inches ahead of the sickle on a standard header. With a pick-up reel and floating cutterbar, the reel axle should be about 8 inches ahead of the sickle.

A bat reel should be operated just low enough to tip the stalks onto the platform. The tips of the fingers on a pickup reel should clear the cutterbar by about 2 inches.

OPERATING PRACTICES

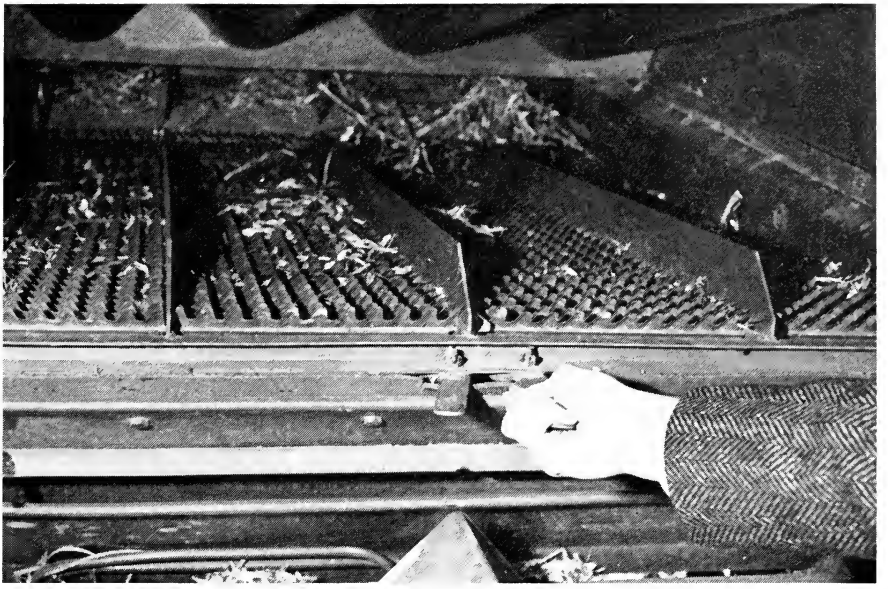
Cut the stalks as low as possible to reduce stubble losses. An automatic header-height control will help reduce stubble height and operator fatigue. In tests at the University of Illinois, a floating cutterbar reduced losses 25 percent compared with a standard header when the soybeans were below 13 percent. Both were tested with a pick-up reel (Fig. 5).

Keep forward speed at or below 3 miles per hour. If stubble is high and ragged, or if separating losses are high, slow down (Fig. 6).

MEASURE YOUR LOSSES

The easiest way to measure harvesting losses is to use a rectangular frame enclosing an area of 10 square feet. Forty beans in an area of 10 square feet is approximately equal to 1 bushel per acre of lost soybeans. For convenience, the frame can be made from heavy cord or clothesline rope so it can be coiled and carried on the combine. The length of the frame should be equal to the cutting width of your combine header, and the width should be as listed in Table 1. Tie four pins to the rope frame to mark the corners. Make the pins of No. 9 wire, 3 to 4 inches long, so they can be pushed into the ground to hold the frame tight (Fig. 7).

Procedure. Stop your combine well away from the edges of the field, disengage the platform drive and raise the platform, then back up 15 to 20 feet. Place the frame across the harvested rows behind the combine, count the loose beans, beans in pods on or off the stalks, and beans on the stubble inside the frame, and divide by 40. The result will be the total loss

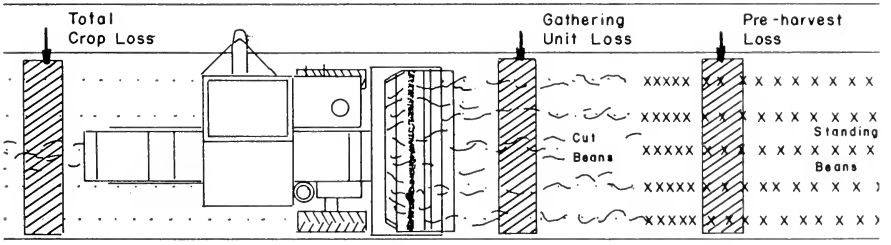


The chaffer is adjusted to allow the fan blast to separate chaff from soybeans and not allow too much coarse material through. The sieve is adjusted to allow only soybeans through. (Fig. 6)

in bushels per acre. This is the sum of preharvest and harvesting losses. If loss is near 3 percent of yield, continue harvesting.

To measure preharvest losses, place the frame across the rows of standing beans in front of the combine, count the loose beans and beans in pods on the ground and divide by 40. Then subtract this preharvest loss from the total loss found behind the combine to determine total harvesting losses.

If harvesting losses are too high, place the frame across the harvested rows in front of the combine just ahead of the drive wheel tracks. Count all the beans inside the frame, subtract the number of beans found in the preharvest count, and divide by 40. The result will be gathering losses. When making this count, separate the losses into the four types of gathering losses



Where to measure pre-harvest, gathering unit, and total crop losses. (Fig. 7)

Table 1. — Dimensions for a Rectangular Frame Enclosing an Area of 10 Square Feet for Checking Soybean Harvesting Losses

Header width, feet	Width of frame inches
10	12
12	10
13	9.25
14	8.6
15	8
16	7.5
18	6.7
20	6

to make it easier to determine the proper machine adjustments if losses are too high. Cylinder losses plus separating losses can be found by subtracting gathering losses from total harvesting losses.

WHAT ARE REASONABLE LOSS LEVELS?

In 1972, 40 combines operating in central Iowa were checked. The average and lowest harvesting losses are listed in Table 2. Gathering losses accounted for 89 percent of the total harvesting loss. Almost all the gathering losses were shattered beans and loose stalks.

Table 2. — Harvesting Losses for 40 Randomly Selected Combines Harvesting Soybeans in Central Iowa in 1972

	Average (bu./acre)	Lowest (bu./acre)
Header losses		
Shatter losses	1.0	.3
Stalk losses	1.1	.2
Lodged losses	.1	.1
Stubble losses	.3	.0
Total header loss	2.5	.6
Threshing and separating losses	.3	.1
Total harvesting loss	2.8	.7

The average losses in Table 2 are quite low, indicating that field conditions were good and that most operators were doing an excellent job of adjusting and operating their combines. The moisture contents of all soybean samples obtained from the combines were above 11 percent, and preharvest losses averaged less than 0.1 bushel per acre.

If your harvesting losses are greater than the average values in Table 2, take time to find out why and readjust your combine. Your goal should be to keep harvesting losses below 2 bushels per acre.

DRYING SOYBEANS

It may be advantageous to harvest soybeans at moisture levels above those for safe storage to reduce harvesting losses. They should be dried to 13 percent moisture or less for storage periods of 6 months to a year and to 11 percent for longer storage periods.

Soybeans that will be used for seed should be carefully dried to preserve germination. Germination is reduced to less than 50 percent at drying air temperatures above 130° F., while seed-coat cracks will develop at relative humidities below 40 percent. Additional handling results in the seed-coat being removed and bean splitting, thereby reducing germination.

Soybeans to be processed for food purposes need to be treated as carefully as seed beans. Any damage to the seed-coat results in the development of off-flavor in the processed product. These off-flavors are nearly impossible to remove.

Low-temperature or natural-air drying appears to work well for drying soybeans. Air flow rates of 1 to 2 c.f.m. per bushel and sufficient heat to raise the air temperature from 3° to 5° F. can be expected to dry soybeans in less than three weeks with a minimum of seed-coat cracking. The exact amount of time required will vary with initial moisture content of the soybeans and the weather conditions. At relative humidities of 50 to 70 percent, soybeans can be expected to dry to 11 to 13 percent moisture content (Table 3). Final moisture content will depend upon the average relative humidity during the drying period.

The drying fan should be operated continuously, regardless of weather conditions, except when freezing temperatures last more than 24 hours. If temperatures drop below freezing, operate the fan until the temperature of the air coming out of the beans is below freezing (about 12 hours); then shut it off until the outside air temperature rises above freezing. Some reduction in germination can be expected if the moisture content remains above 15 percent for more than a month at temperatures below 60° F. At temperatures above 60° F. the germination can be impaired in a shorter period of time.

Table 3. — Moisture Content to Wh

Relative humidity of entering soybeans, %	*Temperature of* 30	40			
40	9	8.5	8	7.5	7
50	10.5	10	9.5	9	8.5
60	12	11.5	10.5	10	9.5
70	14	13	12	11.5	10.5
80	16	15	14.5	13.5	12.5
90	20	19	18	17	16
100	26	25	24	23	22

As the air enters the soybeans, it will pick up available moisture. As soon as the air is carrying a full load of water, it will pass the rest of the way through the pile without doing any additional drying. This means that the soybeans at the bottom of the pile dry first and those at the top dry last for upward airflows. When the soybeans are dried enough, the air will pass through them without picking up any moisture until it reaches soybeans which have water available.

Rate of drying is controlled by airflow. Degree of drying is controlled by relative humidity for in-bin drying.

HIGH-TEMPERATURE DRYING

High temperature drying is limited to situations where seed-coat cracking and germination are not important. Air of 100 to 190° F. is passed through the soybeans in a batch or continuous flow drier until they reach the desired moisture content. The beans are then cooled and placed into storage.

Bean temperatures should be limited to less than 150° F. to avoid a reduction in oil content.

This publication was written by John C. Siemens, associate professor of agricultural engineering, and Harvey J. Hirning, assistant professor of agricultural engineering.

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