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Reducing Seed Harvest Losses

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REDUCING SEED HARVEST LOSSES[1]

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Although the grain-combine harvester has been used for soybeans since the mid-twenties, little progress was made in reducing soybean harvesting losses until about 1970. At that time the average combine operator, when using a rigid grain platform header, was leaving as much as 10 percent of the crop in the field. The introduction of attachments such as the floating cutterbar and pick-up reel made it possible to reduce harvesting losses to 7 or 8 percent.

More recently, combine headers specifically designed for soybeans have become available. Several combine manufacturing companies have introduced headers that have a built-in flexible cutterbar. A low-profile, row-crop header was introduced by John Deere and Company in 1974.[3] With these new headers, you can reduce harvest ing losses to about 4% of yield. An alert combine operator can reduce losses even further under some harvesting conditions.

To keep harvest losses to a minimum, you need to know what types of losses occur, how to measure those losses, and what equipment, adjustments, and practices will enable you to harvest soybeans most efficiently.

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[1]Much of this article is taken from information presented in, "Illinois Growers Guide to Superior Soybean Production" Illinois Coop. Ext. Ser. Circular 1200, Urbana-Champaign, IL.

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[3]Trade names are used in this publication solely for the purpose of providing specific information. Mention of a trade name, proprietary product, or specific equipment does not constitute a guarantee or warranty by the University Illinois or the U.S. Department of Agriculture, and does not imply approval of the named product to the exclusion of other products that may be suitable.

Types of Soybean Losses

Some soybean losses result, not from the operation of the combine, but from natural causes before harvest. These preharvest losses are soybeans that have fallen to the ground by the time harvest begins. If soybeans that are ready for harvest are then subjected to several alternating periods of wet and dry weather, your preharvest losses could be as high as 25 percent. To avoid such high losses, you should plant varieties that are resistant to shattering and harvest early. You can usually keep preharvest losses low by harvesting soybeans shortly after their moisture content reaches 13% for the first time.

As long as you take these precautions, preharvest losses should account for a relatively small part of your total soybean losses. Your most important concern will be to reduce losses that occur during the gathering, threshing, separating, and cleaning operations at harvest.

Gathering

Gathering, or header, losses are soybeans that are not gathered into the combine. These losses are caused by the action of the cutterbar, reel, and auger. They account for more than 85 percent of the total soybean loss at harvest. There are four kinds of gathering losses. Shatter losses are shelled beans and detached bean pods that are shattered from stalks by the header and fall to the ground without going into the combine. Stubble losses are soybeans in pods remaining on the stubble. Stalk losses are soybeans remaining in pods attached to stalks that were cut but not delivered into the combine. Lodged losses are beans remaining in pods attached to stalks that were not cut or that were cut at heights greater than that of the stubble.

Threshing, Separating, and Cleaning

Soybeans are easy to thresh, separate, and clean. They 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 unthreshed beans remain in pods that pass through the combine and when beans are cracked by the cylinder. Separating, or straw walker, losses occur when shelled beans are carried out the back of the machine with the stalks (these losses are usually insignificant unless the combine is overloaded). Cleaning, or shoe, losses occur when shelled beans are carried over the chaffer, or top, sieve and out the back of the combine.

Measuring Soybean Losses

The easiest way to measure harvest losses is to enclose an area of approximately 10 square feet within a rectangular frame and count the beans remaining in that area after harvest. If you count 40 beans within the frame, your soybean loss is approximately 1 bushel per acre.

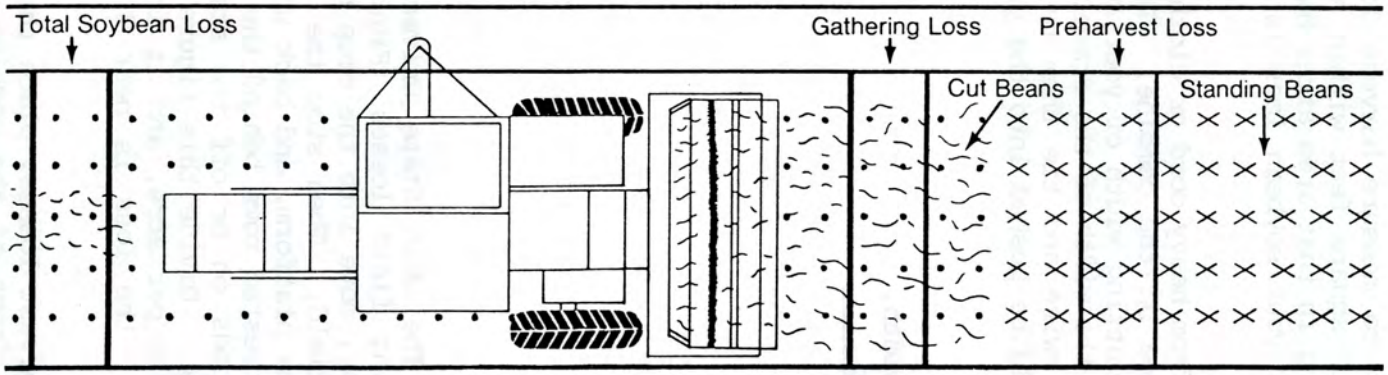
Make the frame from heavy cord or clothesline, so you can coil it and carry it with you on the combine. The length of the frame should be equal to the cutting width of your combine header. Use the list above to determine the width of the frame. Make four pins 3 to 4 inches long from No. 9 wire and tie them to the frame to mark the corners. The pins should be pushed into the ground to hold the frame tight.

Header width, feet	Frame width, inches
10	12
12	10
13	9 1/4
14	8 1/2
15	8
16	7 1/2
18	6 3/4
20	6
22	5 1/2
24	5

Researchers at The Ohio State University have developed a procedure for determining field losses (Figure 1). Operating the combine in the normal way, move into the crop until you are well away from the edge of the field. Then stop the combine, disengage the platform drive, raise the platform, and back up 15 to 20 feet. Place the frame across the harvested rows behind the combine, and count the loose beans, beans in pods on or off the stalks, and beans on the stubble inside the frame. Divide this figure by 40. The result is the total loss in bushels per acre, and it includes both preharvest and harvest losses. If the loss is near 3 percent of the yield, continue harvesting.

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

Figure 1



The shaded areas in the drawing above show where you should place a frame to measure your total soybean loss, preharvest loss, and gathering loss.

If your harvesting losses are too high, you should use the following procedure to determine where most of these losses are occurring. First, 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 is your gathering loss. When making this count, be sure to note how many of each of the four types of gathering losses there are, so you will know where to make adjustments in the machinery. You can find the cylinder and separating losses by subtracting the gathering losses from the total harvesting losses.

Reducing Soybean Losses

Header Design

In 1976, University of Illinois researchers conducted a large-plot experiment at Urbana to compare the effects of variety, narrow row spacing, and header design upon soybean losses during harvest. Corsoy, Amsoy-71, Beeson, and Williams varieties were grown in row spacings of 7 and 30 inches. The target population was about 170,000 plants per acre for the 7-inch rows and 125,000 for the 30-inch rows. The data in Table 1 show the effect of row width and variety upon preharvest loss and yield. In 7-inch rows, the yield of Corsoy increased 8 percent, that of Beeson 4 percent, and Amsoy-71 2 percent compared to their yields in 30-inch rows. Growing Williams in 7-inch rows did not increase its yield.

Table 2 compares the header losses that occurred when various types of headers were used in 30- and 7-inch soybean rows. Header loss with both types of platform headers was about 30 percent less in 7-inch than in 30-inch rows. In 30-inch rows, the row-crop header proved to be the most efficient type under the conditions of our experiment.

The data obtained during the 1976 season proved that a floating cutterbar header with air-jet guards reduces harvest losses by 45 percent, compared to a conventional floating cutterbar header. But the flexible floating cutterbar header, either with or without the air-jet guards, is even more efficient. In fact, the air-jet system is probably unnecessary because the addition of it did not significantly increase the harvesting efficiency of the flexible floating cutterbar. This type of 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.

Table 1. Effect of row width and variety upon pre-harvest loss and yield of soybean.

	Preharvest loss, Percent	Yield, bushels per acre
Amsoy-71		
7-inch rows	1.8	45.8
30-inch rows	2.2	44.9
Beeson		
7-inch rows	5.1	38.9
30-inch rows	4.3	37.3
Corsoy		
7-inch rows	0.2	53.3
30-inch rows	0.2	49.3
Williams		
7-inch rows	1.1	37.2
30-inch rows	0.4	37.7

Table 2. Effect of header type and row width on header loss.

	Total header loss, percent	Reduction in loss, percent
Flexible floating cutterbar		
7-inch rows	2.4	37
30-inch rows	3.8	
Flexible floating cutterbar with air-jet guards		
7-inch rows	2.4	30
30-inch rows	3.4	
Floating cutterbar		
7-inch rows	6.3	28
30-inch rows	8.7	
Floating cutterbar with air-jet guards		
7-inch rows	3.3	33
30-inch rows	4.9	
Row-crop header		
30-inch rows	1.4	

To determine which header has the most potential for increasing profits, we analyzed the harvesting costs and crop yields with various combine header configurations in 7- and 30-inch row spacings. We used yield and loss data for Corsoy because this variety produced the highest yield in both row spacings. The study was conducted for an average central Illinois grain farm that had 250 acres of soybeans and 300 acres of corn.

By reducing harvest losses, the row-crop header, in spite of its higher cost, returned $5 per acre more than the flexible floating cutterbar in 30-inch rows. The flexible floating cutterbar, however, returned $25 per acre more in 7-inch rows than the row-crop header in 30-inch rows. The platform header in 7-inch rows proved more profitable because the yield was four bushels per acre higher at that row spacing, the purchase price of that header was lower, and because it held harvest loss to an acceptable level.

In this analysis we assumed that control of weeds was equal in both row spacings, but realized of course that mechanical cultivation is impossible in 7-inch rows. We also assumed that the row-crop header was operated at 5.0 miles per hour (mph) and the flexible cutterbar at 3.5 mph. We did not include a cost factor for the timeliness of harvest operations.

It is obvious from our analysis that under good production management solid-seeded soybeans can be profitably produced. Farm equipment manufacturers have made equipment available that, if used properly, can keep harvest losses below 4 percent, regardless of the row spacing.

Combine Adjustments

To take full advantage of the time available for harvesting, make all necessary repairs and major adjustments well before the harvest season. Using the operators manual as a guide, thoroughly repair, lubricate, and adjust the combine. Familiarize yourself with the adjustments in the manual and those described here, so that you can make adjustments easily and quickly in the field.

Studies conducted by researchers at The Ohio State University, the University of Illinois, and Iowa State University have proven that to make any major gains in harvesting efficiency, the header must be properly adjusted to reduce gathering losses, particularly shatter lodged and stalk losses. The header must cut close to the ground to avoid leaving soybeans on the stubble and shattering them from the stalks. To further reduce shatter losses, it must be able to handle the beans 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. Keep the knife sharp and replace broken or badly worn sections. Adjust the wear plates to minimize knife vibration. Align the guards and adjust the knife vibration. Align the guards and adjust the knife clips, so the knife can move freely and cut efficiently.

Proper reel adjustments are particularly necessary to keep losses low. 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 will shatter soybeans excessively if it turns too fast, but it may drop stalks or allow too many of them to be recut if it turns too slowly.

The reel axle should be 8 to 12 inches ahead of the sickle. Several manufacturers are now providing headers with a built-in flexible cutterbar. When harvesting short plant material, you may need to move the reel axle nearer the cutterbar.

To prevent excessive threshing and separating losses and still keep the soybeans clean, the threshing and separating mechanisms must be kept properly adjusted.

Probably 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 operating speed. In some machines this starting point is the cylinder-beater cross-shaft; in others it is the primary countershaft. Most combines are designed to operate at the proper speed when the speed control lever of the engine is in the maximum position. If the separator is 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, check the operators manual or have the work done by your 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, you should adjust, in addition to the cylinder speed, the cylinder-concave clearance, the sieve settings, and the speed and opening of the cleaning fan. If you follow the operators manual closely in making these adjustments, you should have to make only minor adjustments in the field.

For most conventional combines, the recommended cylinder-concave clearance for soybeans is 3/16 to 3/8 inch at the back and 3/8 to 1 inch at the front. The cylinder and fan speed must be adjusted to fit your 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 to 650 rpm. As soybeans dry, lower the cylinder speed to reduce breakage; 450 to 500 rpm should be high enough for soybeans that are below 13 percent in moisture content.

Rotary Combines

One way to improve the quality of soybeans is to reduce the mechanical damage caused by the combine threshing mechanism during harvesting. Efforts to reduce threshing damage while increasing capacity have resulted in the development of rotary threshing equipment. Rotary combines have one or more rotors, instead of the conventional cylinder and straw walkers for threshing and separating grain from crop material. The crop material is swirled around the rotor and passes over concaves several times. The threshing action of the rotor is reported to be more gently than that of the cylinder.

New Holland was the first company to introduce the concept of rotary, or axial-flow, threshing with its TR-70 combine. International Harvester followed with its single-rotor, axial-flow combine. In 1978 Allis-Chalmers introduced its N-Series rotary combine, and in 1979 White introduced its Model 9700 axial-flow combine. It appears that the rotary combines are here to stay. But in spite of the popularity of these new combines, the conventional cylinder combines will probably be around for a long time.

A study was conducted at the University of Illinois in 1977 to determine the damage to soybeans caused by rotary and conventional threshing mechanisms. In this study an International 1460 Axial-Flow (single-rotor) combine, a Sperry New Holland TR-70 (double-rotor) combine, and John Deere 7700 (conventional rasp-bar-cylinder) combine were tested under field conditions. The quality of the harvested soybeans was evaluated, and the threshing and separating losses for each combine were determined. All three combines were equipped with 20-foot-wide, floating cutterbar headers.

The results of the study, which are summarized in the following paragraphs, pertain only to the particular combines and soybean variety (Amsoy-71) tested in this study and to the particular conditions under which the study was conducted.

The percentage of soybean splits was significantly higher for the conventional cylinder than for the single- or double-rotor threshing mechanisms at similar peripheral threshing speeds. However, when the mechanisms were operated within the range of cylinder or rotor speeds recommended by the respective manufacturers, the percentage of splits did not exceed the allowable 10 percent limit for U.S. No. 1 grade soybeans.

With all three mechanisms, the percentage of splits increased as the peripheral threshing speed of the cylinder or rotor was increased. The increase in splits was less with the rotary threshing mechanisms than with the conventional cylinder.

With all three mechanisms, threshing and separating losses decreased as the cylinder or rotor speed was increased. These losses ranged from 0.2 to 0.5 percent of yield. With the rotary combines they were significantly higher at the lowest rotor speed than at the higher speeds.

Increasing the concave clearance generally decreased the percentage of splits for all three combines, although this adjustment had less effect than changes in cylinder or rotor speed. The percentage of splits was not significantly affected by concave adjustment until after a minimum clearance was reached for the rotary combines.

The susceptibility of soybeans to breakage and the seed-coat crack percentage were not affected significantly by the type of threshing mechanism or the cylinder or rotor speed. Nor did these factors affect other criteria used in grain-inspection grading, such as test weight, percentage of damaged kernels, and percentage of foreign material.

We found that improvements were needed in the design of augers and elevators that convey soybeans from the clean-grain auger to the grain tank. The percentage of splits that occurred as soybeans were elevated from the clean-grain auger to the grain tank averaged 1.0 percent for the conventional cylinder, 0.6 percent for the single-rotor, and 1.4 percent for the double-rotor combines.

The results of studies at The Ohio State University and the University of Illinois indicate that adjustments to rotary combines may be less critical than those to conventional rasp-bar-cylinder combines. However, the results of these studies also indicate that during threshing and cleaning a properly adjusted conventional combine can keep soybean damage well below the level that leads to dockage.

Weeds

Although it has long been recognized that weeds are detrimental to soybean production, only in recent years has their effect on combine harvesting efficiency been studied. University of Illinois researchers conducted experiments at Urbana, Illinois, in 1968 and 1969 to determine the effect of controlled infestations of smooth pigweed and giant foxtail upon soybean yields and harvesting losses.

In these experiments the smooth pigweed infestation (one pigweed per foot of row) reduced the average yield 25 to 30 percent. The same degree of giant foxtail infestation reduced yield 13 percent. but the weeds did not cause significant losses at the header during harvest as long as the weeds were desiccated before harvest began. The results of the experiment also indicate that harvesting soybeans before frost has desiccated the weeds results in excessive threshing and separating losses unless the ground speed of the combine is reduced. In some pigweed infested plots, 4.4 percent of the crop was lost during threshing and separating when it was harvested at 3 mph. whereas only 0.7 percent was lost when ground speed was reduced to 1 mph. At both speeds about 1 percent of the crop was lost during threshing and separating when it was harvested after the pigweed had dried.

Soybean Harvesting Research

Improved productivity of the harvesting system is necessary for the agricultural producer. The conventional reciprocating cutterbar limits combine travel speed to 3.5 mph or less, holding soybean throughput of modern combines to levels that are considerably below the capacities of both the threshing and separating units. Combine headers specifically designed for soybeans can remove this limitation. The John Deere Row-Crop header permits higher travel speeds that result in increased throughput of modern combines to levels that are considerably below the capacities of both the threshing and separating units. Combine headers specifically designed for soybeans can remove this limitation. The John Deere Row-Crop header permits higher travel speeds that result in increased throughput while maintaining low loss levels. However, the current trend toward planting soybeans in narrower row spacings to maximize yield potential emphasizes the importance of maintaining the ability to harvest soybeans in a continuous swath.

Rotary impact cutting seems to offer the potential for high combine travel speeds and high throughput for soybeans. Investigations of impact cutting at the University of Illinois demonstrated that soybean harvest losses could be reduced to levels lower than those resulting from conventional cutterbar configurations. Rotary disk and rotary drum mowers and haybines have recently been introduced in the United States by farm equipment manufacturers, after receiving wide acceptance by European customers. These units provide high speed rotary impact cutting of a continuous swath and can function at relatively high travel speeds. If the losses produced by an adaptation of this cutting unit can be held to levels comparable to those obtained with existing commercial cutterbar systems, an improvement in soybean harvesting system productivity would be possible.

The objectives of this study were:

1. To collect and measure the harvest loss associated with rotary blade cutters.

2. To evaluate the effect of forward speed, row spacing, and disk design on harvest loss.

Three Vicon disks were mounted on a rotary disk mower frame and operated at 3000 rpm on a laboratory test stand (Figure 2). Vicon manufactures a "standard" disk, with a smooth disk contour, and a "wing" disk (Figure 3) with three small metal pieces welded to the regular disk at an upward angle. Both styles were tested to evaluate effects of blade design on harvest losses.

Wells-II variety soybean plants were gathered at harvest, stored, and prepared for testing. Narrow row soybean production was simulated by using three rows of soybeans for each test run. Both 7.5 in. and 10 in. row spacings were evaluated. The soybean rows were mounted on a carriage and driven through the cutterbar at travel speeds of 4.5, 6.75 and 9.0 mph. Harvest losses were gathered from the collection tray and weighed, and moisture content and net yield were determined. High speed movies were taken and the movies were used as an aid in determining the percentage of actual loss collected. Only beans that fell in front of the cutterbar were considered to be lost.

For both the standard and winged disks (Tables 3 and 4), loss levels observed at the 4.5 mph travel speed were significantly higher than those at 6.75 mph and 9.0 mph travel speeds for both 7.5 in. and 10 in. row spacings. The higher momentum of the soybean plants at higher relative travel velocities tended to carry shattered seeds along with the plant onto the header. However, no significant difference in loss levels was detected between the 6.75 mph and 9.0 mph speeds.

With the exception of one treatment (4.5 mph travel speed with 10 in. row spacing and standard disk cutterbar), all losses recorded were below one percent of the gross yield. Loss levels for the higher travel speeds (6.75 mph and 9.0 mph) were below 0.55 percent. These recorded loss levels were lower than the losses that actually occurred. Analysis of the film revealed that, on the average, approximately 60 percent of the beans shattered along the length of the collection tray were collected during the tests.

The losses encountered with the wing disk cutterbar configuration appear to be significantly lower than those encountered with the regular disks. All losses for the wing disk configuration were below 0.53 percent and losses at the higher relative travel velocities were below 0.20 percent. Vicon manufactures mowers and hay conditioners

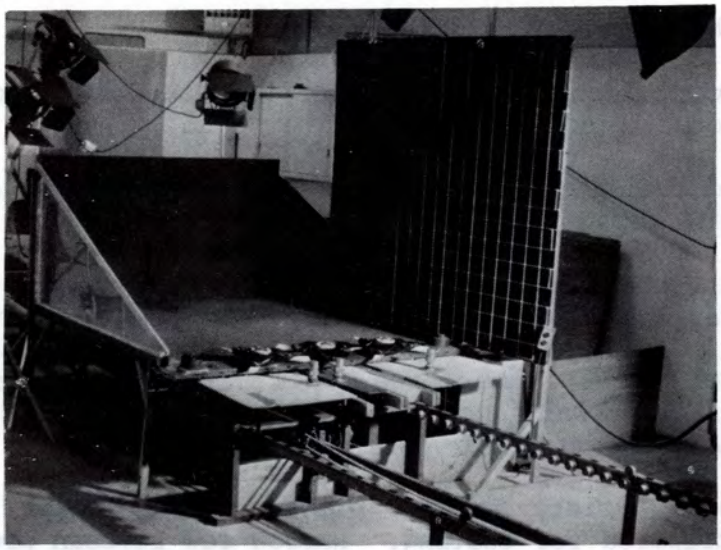


Figure 2. Laboratory test stand used to evaluate rotary disc mowers.

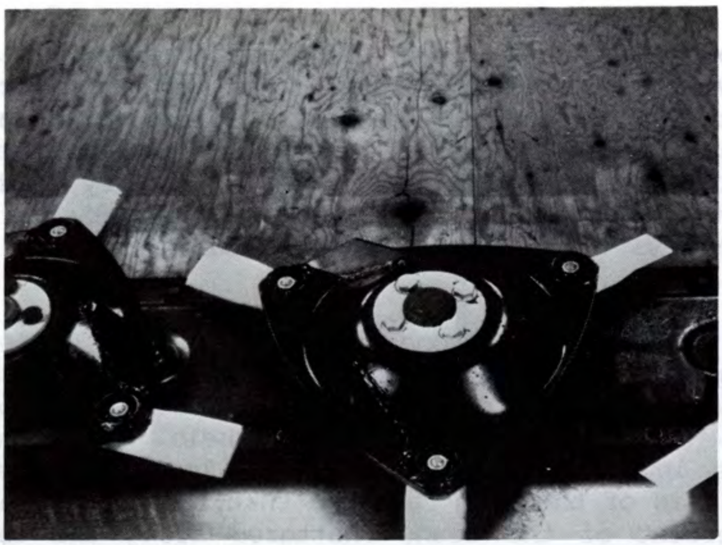


Figure 3. Close-up view of a modified Vicon wing disc.

Table 3. Soybean harvest loss and yield with the standard disk cutter configuration.

Row spacing, in.	Travel velocity, mph	Total harvest loss,[1]	Gross yield, bu/acre
7.5	4.5	0.85 a	70.2
	6.7	0.23 c	84.3
	9.0	0.28 bc	76.4
10.0	4.5	1.05 a	61.5
	6.7	0.54 b	61.7
	9.0	0.13 c	55.0

[1]Data are averages of three replications with Wells-II variety at 10.5 percent and moisture (W.B.). Numbers with the same letters do not differ significantly at the 5% level, based on Duncan's Multiple-Range Test.

Table 4. Soybean harvest loss and yield with the wing disk cutterbar configuration.

Row spacing, in.	Travel velocity, mph	Total harvest loss,[1]	Gross yield, bu/acre
7.5	4.5	0.50 a	88.6
	6.7	0.12 b	93.0
	9.0	0.18 b	91.0
10.0	4.5	0.52 a	64.2
	6.7	0.18 b	63.5
	9.0	0.15 b	66.4

[1]Data are averages of three replications with Wells-II variety at 10.5 percent seed moisture (W.B.). Numbers with the same letters do not differ significantly at the 5% level, based on Duncan's Multiple-Range Test.

which utilize the regular disks and wing disks respectively. The wing disks supposedly produce a greater upward air stream which helps carry the hay up into the crimper. The difference in airflow could account for the difference in loss levels as the greater airlift would suspend a shattered bean for a longer time and allow the seed more time to pass over the cutterbar and enter the header.

We concluded that soybean losses associated with a rotary disk mower can be expected to be below 2%, that soybean losses at the 4.5 mph forward speed were significantly higher than those at the 6.75 mph and 9.0 mph forward speeds, and that soybean losses using the regular disk cutterbar at 4.5 mph forward speed.