SDSU Extension

iGrow Wheat

BEST MANAGEMENT PRACTICES

Chapter 28:
Minimizing Combine Harvest Losses in Wheat

Daniel Humburg

Yield losses can represent the difference between making and losing money. This chapter is intended to provide operators with information needed to minimize harvest losses (Fig. 28.1).

Figure 28.1. Examining the concave area and the cleaning shoe in a rotary combine during the wheat harvest.

Introduction to harvest losses

Producers invest time, energy, capital, and management into successfully bringing a crop to maturity. The culmination of this investment is reached at harvest time, which is justifiably hectic and stressful, as producers rush toward the finish line. Careful attention to crop conditions, machine settings, and operator behavior will bring the maximum percentage of the crop out of the field. Conversely, inattention can result in unacceptably large amounts of grain left in the field.

The strong desire to harvest a mature crop can induce producers to rush the process. Minimizing losses requires that time needs to be spent counting kernels on the ground behind the combine and then making the appropriate machine adjustments. Consider that a mere reduction in harvest losses from 4 to 2% in 40-bu/acre wheat will recover an additional 0.8 bushels/acre. At $7/bushel these adjustments would recover $896 over a single 160-acre field.

Given today's equipment, it is not possible to completely eliminate harvest losses. Timely and efficient harvests involve striking a balance between the goals of minimizing field losses and rapidly recovering the crop. Properly adjusted combines should have harvest losses that are less than 3%. Losses in excess of 3% may indicate opportunities to adjust the combine and recover more grain.

Combine processes and losses

An understanding of the processes that take place in the combine is useful prior to making any changes or adjustments to reduce losses. Figure 28.2 represents the combine harvester through its sequence of processing steps. The processes in green are those that normally lead to lost grain. The first process is the cutting, gathering, and transport of the crop that occurs at the combine head.

Research conducted at North Dakota State University has indicated that a large portion of total harvest losses can be attributed to the process of getting the grain into the combine. Table 28.1 shows 63 to 82% of the total losses that occur in wheat harvesting were attributed to shatter and cutter bar losses.

The next process that produces measureable losses is threshing. The grain is freed, or threshed, from the seed head through the action of impact and rubbing at the cylinder or rotor of the combine. Losses here typically occur due to incomplete threshing, where grain is retained in the head, and then passes through the separating and cleaning system and out of the machine. Another form of loss that occurs here is damage to the threshed grain from improper adjustments of the threshing system (namely, 'skinned' and/or broken kernels).

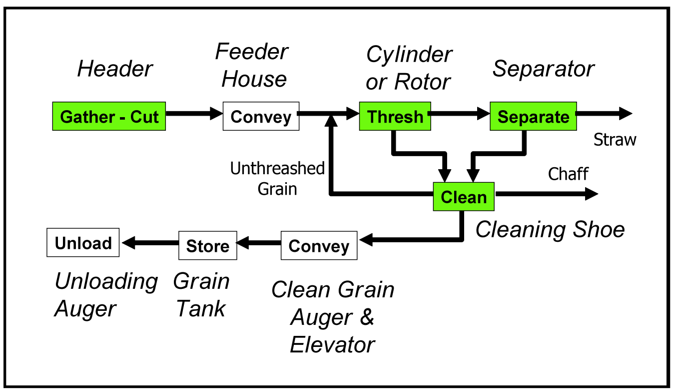

Figure 28.2. Steps involved in the machine harvest of grain. Processes highlighted in green indicate where the losses typically occur. (Source: *Engineering Principles of Agricultural Machines* by Srivastava Goering and Rohrbach. Published by ASABE 1994.)

The separator system separates the loose grain from the Material Other than Grain (MOG). In conventional combines, this is accomplished through straw walkers that elevate and accelerate the straw upward, while gravity pulls the grain downward. Rotary machines are able to use larger centrifugal forces to work the grain outward through the mat of straw. Straw is retained inside the threshing and separator cage until it is discharged at the rear of the separator. Losses occur when grain is discharged with the MOG.

The cleaning system uses a shaking action and air blast to lift or blow straw and chaff up and out of the machine. Heavier grain is allowed to pass through the sieves and be collected. Losses occur when the grain is blown out with the chaff. Insufficient air flow may produce a grain sample with high amounts of foreign matter. Excessive foreign matter in the grain (evidenced in the grain hopper) will result in dockage. Material that is too large to pass through the sieves, but too heavy to be blown off, is collected at the tail of the cleaning shoe and recycled for additional threshing. Before looking at each of these processes in more detail, it is essential to determine the level of total harvest losses and to assign them to the part of the machine responsible.

Table 28.1. Average machine losses in small grains from a study conducted by North Dakota State University.
(Source: Vern Hoffman, NDSU)

Type of machine loss	1974				1975	
	Hard Red Spring Wheat	Durum	Barley	Oats	Hard Red Spring Wheat	Barley
Shatter and Cutter Bar (Bu/Acre)	0.70	0.66	1.13	0.54	0.98	2.57
% of Total Loss	65%	63%	63%	47%	82%	87%
Cylinder and Separation Loss (Bu/Acre)	0.37	0.39	0.66	0.6	0.21	0.39
% of Total Loss	35%	37%	37%	53%	18%	13%
Total Loss (Bu/Acre)	1.07	1.05	1.79	1.14	1.19	2.96
Crop Yield (Bu/Acre)	21.10	28.20	46.20	48.80	41.70	52.70
% of Crop Lost	4.80%	3.60%	3.70%	2.30%	2.80%	5.30%

Determination of harvest loss

To reduce harvest losses, a producer must first determine the losses with the current machine settings. Wheat is generally not a difficult crop to harvest, and modern combines are very well adapted to recovering a high percentage of the crop. If a check of losses finds 2% of the yield on the ground, then the producer can smile and continue. However, if losses exceed 3% of total yield, the analysis should continue to identify where the losses are occurring.

A check of machine losses should be conducted any time conditions change that could affect machine performance. Drying conditions as the day progresses will change crop characteristics and the performance of the machine systems. Moving to a new field, with a different variety or maturity, may cause losses from a different machine setting. Checking for losses and making appropriate adjustments is time well spent because:

- The operator will develop a better understanding of the behavior of the machine, and become more adept at fine-tuning it for small variations in condition.
- The amount of grain left on the ground in the field can be minimized.

Once the combine has been adjusted to produce minimal losses, subsequent checks and tuning will not take long. It's a good idea for the operator to take a break, and use this time to count kernels on the ground!

Measuring field harvest losses

Harvest losses are determined by counting the kernels on the ground behind the combine. This section will discuss methods to determine:

- Pre-harvest losses.
- Losses at the header.
- Losses from the threshing system.
- Losses at the separator.
- Losses from the cleaning system.

Counting twenty (20) to twenty-two (22) kernels of wheat within a one-square-foot area on the ground is equivalent to a loss of one bushel per acre. While this number does depend upon the size of the kernels, 22 will be used in this discussion. To start with, a convenient means of marking a known area on the ground is needed. This can be achieved by creating a square frame of stiff wire or other material with dimensions of 1-foot by 1-foot (1'x1').

Alternatively, a length of stiff wire 42.5" long can be formed into a circle and welded to produce an inside area of 1 ft^2. Make something that is convenient to use that can be stored in the cab. Now the frame is ready to be periodically used to determine grain kernels on the ground (per square foot) in estimating losses.

Consistency of observation is important to compare results from one assessment to another. The number of seeds per ft^2 should be made in an area of relatively uniform crop and away from headlands. Take a full swath and operate at constant speed. Stop the machine and the separator; safety is always important. Now use the 1 ft^2 frame to count kernels of grain at locations as indicated in Figure 28.3.

First, check in the standing crop for pre-harvest shatter losses and broken stems in or around the locations marked "A." Determine the average number of kernels in a 1 ft^2 area. If grain is found on the ground, it will not be attributed to the machine settings. This loss cannot be reduced with any amount of machine adjustment, but it is important to measure it so that the machine losses can be accurately separated from pre-harvest losses. Determining losses in swathed wheat and from stripper heads is discussed later.

Next, the grain on the ground behind the header, but forward of the discharge pattern, in areas marked "B," is measured at several locations. This will include counting kernels from heads that were cut or broken from the stem but not recovered by the combine header. Again, determine the average kernel loss in 1 ft^2. Subtract the kernels/ft^2 of pre-harvest loss from the kernels/ft^2 behind the head to determine losses attributable to the head.

Last, determine the grain loss behind the machine at location "C" in Figure 28.3. Avoid the area immediately behind the machine, particularly if the separator was allowed to empty, and move farther back where the machine was operating steadily. Here it is necessary to determine the width of the distribution of the residue. If no significant spreading is being done, then the width of the discharge is essentially equal in feet to the width of the sieves. If the residue spreader can be easily turned off, it may make it easier to conduct this part of the test. When the combine is distributing the residue wider than the cleaning shoe, these measurements should be done across the residue pattern width.

Determine the width, in feet, of this pattern. Then use the frame to measure losses on the ground in a number of locations within this swath as shown in Figure 28.3. Examine threshed grain heads in these areas for any grain that was not knocked out of the head by the threshing system and record this number for each site.

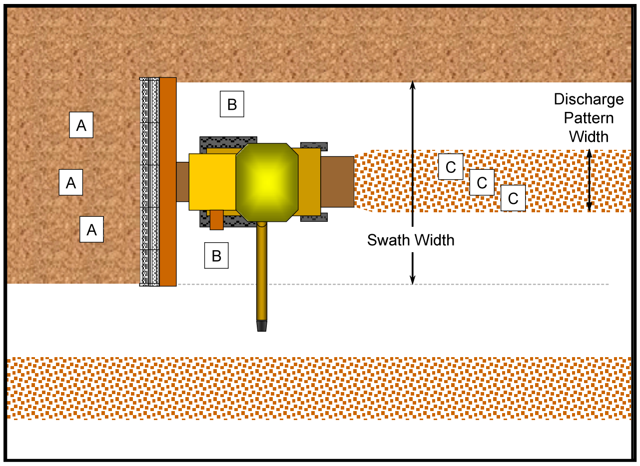

Figure 28.3. Locations using grain platform head to determine pre-harvest and machine losses in small grain harvest. (Illustration by Daniel Humburg)

Average the kernel counts at the locations across the discharge pattern to find the number of kernels per ft². Now subtract the combined pre-harvest and header losses (average count at the "B" locations) from the average in the areas marked "C." This value represents the kernel losses from threshing, separating, and cleaning, but it is concentrated in the residue swath. To distribute these losses evenly across the header swath width, this value is multiplied by the ratio of the residue width divided by header swath width. Now the bushel(s) per acre losses from the machine processes can be determined, as follows:

Preharvest loss (bu/acre) = Average kernels/ft² in area A / 22
Header Loss (bu/acre) = Average kernels/ft² in (B – A) / 22

Threshing, Separator, and Cleaning Loss (bu/acre)
= Average kernels/ft² in (C – B) × (residue width/header swath width) / 22

Threshing Loss Only (bu/acre)
= Average unthreshed kernels/ft² × (residue width/header swath width) / 22

Total machine losses are equal to the sum of the losses at the head plus losses from threshing, separating, and cleaning. If the combine is equipped with a yield monitor, it may be used to determine the percent losses. Percent machine losses are determined as follows:

$$\text{Percent Machine Loss} = \frac{\text{Machine Loss (bu/acre)}}{\text{Machine Loss (bu/acre)} + \text{Harvested Yield (bu/acre)}} \times 100\%$$

$$\text{Percent Header Loss} = \frac{\text{Header Loss (bu/acre)}}{\text{Machine Loss (bu/acre)} + \text{Harvested Yield (bu/acre)}} \times 100\%$$

$$\text{Percent Separator Loss} = \frac{\text{Separator Loss (bu/acre)}}{\text{Machine Loss (bu/acre)} + \text{Harvested Yield (bu/acre)}} \times 100\%$$

$$\text{Percent Threshing Loss} = \frac{\text{Threshing Loss (bu/acre)}}{\text{Machine Loss (bu/acre)} + \text{Harvested Yield (bu/acre)}} \times 100\%$$

While losses are being measured on the ground behind the combine, it is also worthwhile to look for concentrated losses or leakage. It is not that unusual to produce losses from a loose elevator door, an access panel or a worn auger trough. This might be more visible under the combine and ahead of the separator discharge pattern. The combine can be backed up after stopping to expose this area without altering the procedure for measuring ground losses as described above.

Table 28.2. Sample yield loss calculations, part 1 (Source: Daniel Humburg)

- Wheat is harvested with a 30-foot grain head.
- While operating in a uniform crop area, the operator cuts a 29.5 ft swath.
- The operator adjusts the ground speed to achieve an appropriate load on the threshing and separator systems.
- The combine monitor indicates a yield of 43 bushels per acre.
- Residue is distributed across a pattern that is 12 feet wide.
- After stopping, multiple kernel counts are taken at locations A, B, and C from Figure 28.3.
- Kernals of grain in threshed heads found at C are also counted.
- Table 28.2 illustrates the seed count and loss calculations from the given example.

Table 28.2. Sample calculations, part 2. (Source: Daniel Humburg)

Sample Location	Kernel Counts at Sample Locations					Location Average
	Sample #1	Sample #2	Sample #3	Sample #4	Sample #5	
A	4	6	5	--	--	5
B	32	27	28	--	--	29
C	38	68	76	69	39	57.8
*C found in heads	*6	*12	*15	*13	*7	*10.6

Preharvest Loss (bu/a)	5/22 = 23	0.23
Header Loss (bu/a)	(29-5) / 22 = 1.09	1.09 bu/acre
Threshing Separation & Cleaning Loss (bu/a)	[(57.8 - 29) × (12/29.5)]/22 = 0.53	0.53 bu/acre
* Threshing Loss (bu/a)	10.6 × (12/29.5)/22 = 0.20	0.20 bu/acre
Total Machine Loss (bu/a)	1.09 + 0.53 = 1.62	1.62 bu/acre
Indicated Yield from combine monitor or measured yield	43 bu/acre	
% Machine Loss	1.62/(43+1.62) × 100%	3.63%
% Header Loss	1.09/(43+1.62) × 100%	2.44%
% Separator/Cleaning Loss	(0.53 - 0.20) / (43+1.62) × 100%	0.74%
% Threshing Loss	0.20 / (43+1.62) × 100%	0.45%

Analysis of losses

Once harvest losses have been measured, the operator must determine if the losses are acceptable and if adjustments are required. A rule of thumb is that losses less than 3% may be acceptable. If crop conditions are good and the harvest is not under extreme time constraints, an operator may wish to tune the machine for losses less than these. In the example given above, total machine losses are 3.63% and some opportunity for improvement exists.

As losses from a combine are identified, adjustments will be made to reduce them. For any type of loss, the operator should consider three contributors to machine performance. First on the list is crop condition. Moisture content is an obvious factor, but other condition factors may also arise. The second contributor is machine settings. Combines have a multitude of these adjustments; learning how they affect performance and how they interact with each other distinguishes a good operator. The last contributor to performance is operator input or behavior.

The most important operator choice is the field speed and its impact on material feed rate into the combine systems. Excessive speed will overwhelm even the best adjustments of machine systems. Similarly, under-loading the machine may lead to losses and/or damaged grain. When losses are measured or analyzed, all three of these contributors should be considered.

Header losses

In Table 28.2, 67% of the total losses are occurring at the combine head (2.44% header loss / 3.63% total loss). The operator may wish to explore changes to machine settings to reduce this loss. Adjustments that affect header losses include:

- Reel height.
- Cutter/header height.
- Distance forward from the cutter bar to the reel center.
- The reel speed relative to the vehicle speed.

The operator's manual from the manufacturer of the combine and/or head is the best source for the initial settings. If losses at the head are excessive, the manual should be reviewed for appropriate setting and adjustments for the current crop conditions. The condition of the crop at the start of harvest could differ substantially from the condition for which the head was adjusted in the previously harvested crop.

In general, it is wise to make small adjustments and then recheck the losses. Making multiple changes in one step can increase one form of loss, while decreasing another and not reducing the total combine losses. Newer combines have incorporated additional levels of automatic controls and cab-adjustable machine settings. For example, the speed of the reel is normally adjusted to provide a backward velocity of the reel slightly greater than the forward velocity of the machine so that the grain stems are very gently swept backward across the cutter bar.

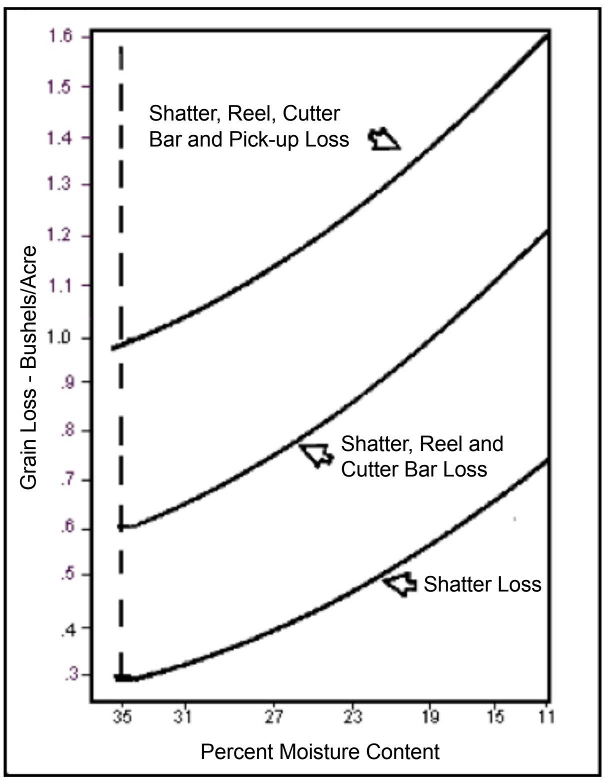

Figure 28.4. Shatter and cutter bar losses with decreasing grain moisture content. (Source: Vern Hoffman, NDSU)

Many current machines are able to automatically change the reel speed to accommodate an increase or decrease in ground speed. However, the operator can change the ratio of the reel-to-forward speed through the machine settings. Figure 28.4 shows how shatter and cutterbar losses increase dramatically as grain moisture content declines.

Reel speed relationships and other header operational settings should be checked and calibrated at the start of harvest or when excessive losses occur. If previously adjusted for a different crop or for late season conditions, it is wise to reset these settings to the suggested starting conditions for wheat or small grain. From this point, small changes can be used to tune the machine for the current crop.

Cutting height (at the header) is an operator input that can affect header losses, as well as losses in other parts of the system. The combine operates best with a steady flow of crop through it. Header height should be changed as crop height and yield vary in the field to maintain a uniform flow of material through the combine. Changing the cutting height will change the ratio of grain to MOG, which will affect the performance of threshing, separating, and cleaning systems. Crop management may also influence the height setting decision; for example, choosing to bale the wheat straw or managing a no-till operation in a semiarid zone.

Threshing system losses

Threshing is accomplished in a combine by a combination of impact and rubbing, which dislodges the grain kernels from the plant head. The efficiency of this process is affected by crop conditions, machine settings, and operational decisions. Crop moisture content is the primary condition factor affecting threshing. Machine settings that affect threshing include the rotor or cylinder speed, the concave type and spacing, and hardware settings that determine the speed of passage of straw through the system.

Operator behavior that most affects the threshing process is the feed rate of material. The crop yield, cutting height, and vehicle speed together combine to determine this flow rate. The relationship between cylinder (threshing) loss and forward vehicle speed (feed rate) is shown in Figure 28.5. Clearly operator decisions here will make a big difference in reducing losses.

Conditions, machine settings, and operator settings interact and it is not possible to specify a perfect combination. Again, the operator's manual for the combine represents the starting point for adjustments for the small grain harvest. As with header adjustments, make small changes to a single setting and then check for the effect by measuring losses. In the example given above, threshing losses were nearly 40% of total machine losses. This might suggest an adjustment to allow less grain, which is still attached to the head, to leave the machine.

Since rotor or cylinder speed, and concave gap, and material flow rate can all affect this loss, it is important to make changes judiciously and then check the result. Also, the changes made to the threshing system can easily affect separation losses, cleaning losses, foreign matter, and damaged kernels as well. Consult your owner's manual for the best order of adjustments for your model combine.

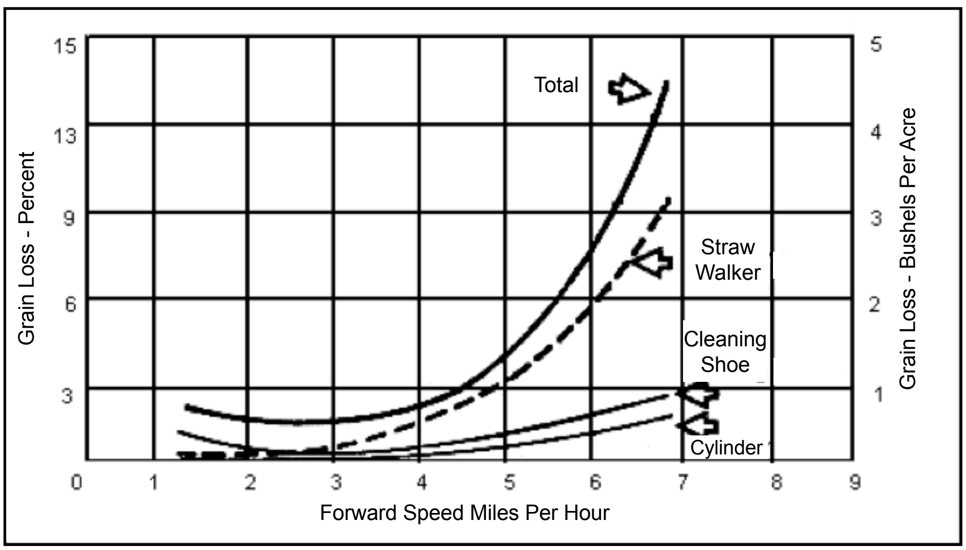

Figure 28.5. Effect of combine speed on threshing, separating, and cleaning losses in a conventional combine. While rotary separators may produce different results, the relative trends should follow those shown here. (Source: Vern Hoffman, NDSU)

Separator system losses

As much as 90% of the grain is actually separated at the threshing system under good conditions as threshed grain passes easily through the concave. Loose grain remaining in the straw is then separated by shaking and gravity in a conventional machine, and by centrifugal force in a rotary combine.

Crop conditions, machine settings, and operator choices that affect separation efficiency have much in common with the threshing system. Moisture content, rotor speed, concave gap and material feed rate will affect separation efficiency. However, some changes that increase threshing efficiency will negatively affect separation efficiency. For example, poor threshing may be addressed by narrowing the spacing between rotor/cylinder and the concave or rotor cage.

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This change, however, may decrease the separation efficiency as the mat of straw is tighter and more resistant to grain passing through it. It may also increase the amount of damaged grain in a sample.

As with threshing, it is best to begin with the machine settings recommended in the operator's manual for small grains and then adjust one parameter at a time to reduce process losses. In the example analysis above, the losses from separation were less than 1% of harvestable yield and about 12% of the machine losses, which is acceptable. Note again, the relationship between walker (separator) losses and vehicle speed in Figure 28.5.

It is clear that operating at an excessive speed increases material flow rates and can be costly in terms of grain left in the field. The graph shown in Figure 28.5 is derived from test data with only one machine, so results may vary. Some machines may be more forgiving of changes in speed and material flow, but all combines will follow this general relationship.

Cleaning system losses

Cleaning systems in combines all utilize a combination of air blast to lift off chaff and straw and a shaking action to draw grain downward through the sieves, while moving larger particles to the rear. Again, moisture content of the harvested grain is a crop condition factor that will influence performance. Machine settings that will most affect cleaning system losses include fan speed and sieve opening.

Fan speed must be sufficient to push through the mat of chaff, straw, and grain on the top sieve and thus carry the lighter material off and out. Insufficient fan speed results in high levels of returns and creates a loop of excessive loading on the sieves. Excessive fan speed will, on the other hand, produce air velocities that can carry grain out of the combine.

As with threshing and separation, the operator controls the feed rate of crop materials, and this can dramatically affect the performance of the system. Insufficient feed rate tends to produce uneven flow of material. Excessive speed can overload the cleaning system, which will lead to heavier flow in the returns and/or cause grain to be passed out with the chaff. The relationship between speed and cleaning losses is illustrated in Figure 28.5.

It is also possible to have material poorly distributed on the sieves, which also leads to losses. If grain and MOG are concentrated in an area of the cleaning shoe, it is possible for the fan air to pass around this concentration and leave part of the shoe overloaded. Higher losses and returns will result. See the "Kill Stall" procedure later in this chapter as a means to diagnose this condition. So-called "slugs" are an example of this situation, though much more prevalent in swathed wheat when bunching has occurred.

The field-test procedure described above lumps separator and cleaning shoe losses into one category. If these losses are found to be excessive, it is helpful to identify the source of the problem. One way to check cleaning system losses is to open the sieves fully and perform another loss test. The fully open sieves will result in high returns, and lots of foreign matter in the sample, but will eliminate the cleaning shoe losses. If this reduces the losses found on the ground then the shoe was the source. If not, the separator was the source of the losses and it should be adjusted.

Follow the manufacturer's recommendations for making changes to the cleaning system, but make small changes and check the field losses as changes are made.

Monitors

A trend in combine designs is an ever-greater use of sensors and controls. The ISO communications bus now used in agricultural machinery makes the addition and use of sensor information much easier. Yield monitors are useful for understanding variability in fields, but also simplify the procedure described above for measuring percent losses.

Multiple sensors for grain loss are now designed into the systems for cleaning and separation. These are used to indicate levels of grain loss and are activated by the impact of grain kernels. *While these sensors are valuable as a means of monitoring changes in operation, they should not be treated as a substitute for your eyes/experience.* Rather, once the adjustments are completed for the combine systems and settings to produce low losses for the current crop and conditions, the indicated levels of losses from grain loss monitor on your machine can be safely used. At this point the monitors can be used as an early warning of changes that may occur due to crop conditions, or due to inappropriate loading of the combine. The monitors can help keep the operator and machine systems running with minimal losses at peak machine efficiency.

Kill Stall procedure

The Kill Stall procedure can be extremely useful in diagnosing combine behavior. The procedure is intended to capture the threshing, separating, and cleaning systems in operation.

To perform the procedure, the machine is operated in uniform representative crop at full header width and at operator-selected ground speed such that the combine separator system is loaded. The combine should be in the highest gear range that allows field operation at this speed. The intention is to stall the engine and this will be easier in high gear. When ready to perform the stall, drop the engine speed setting to the low idle speed, while simultaneously pushing the hydrostat, or speed control, to the maximum position, and depressing both brakes. You will want to do this without a full load of grain in the tank!

After the engine stalls, turn off the ignition key. Return the hydrostat to the neutral position. Turn the separator switch and feeder house/header switch to off, and restart the engine to allow it to cool normally, then turn the engine off. This procedure may seem abusive to the machine, but is recommended by some combine manufacturers and can be safely performed. The stall sequence is designed to use the brakes to bring the separator to a rapid halt, rather than having it windmill down as it would if simply disengaged. Don't conduct this procedure if crop conditions are tough (i.e., high moisture), given that restarting the rotor or cylinder would be difficult.

The threshing, separating, and cleaning systems can now be examined to determine much about their operating states. Most new combines provide relatively easy access to these systems, so open any access panels that allow visibility. Examine the distribution of grain and chaff on the chaffer and cleaning sieves.

Overloaded sieves will have excessive grain and chaff left on top. This suggests a lower feed rate, or possibly increasing fan air. The location of the material on the sieves can tell you whether the threshing system is set correctly, or if more material is being processed on one side than the other. Rotary machines will allow shifting of the concave cage to influence the deposition of grain and chaff onto the grain pan. Agitating the material in the threshing/separating system of a rotary combine can indicate its capacity.

Grain found in the straw at the back of the separating system in a rotary machine indicates an overloaded condition and crop flow should be retarded or reduced. Little or no grain in the lower parts of the concave or rotor cage indicates that more capacity exists. Similarly, grain near the top of the straw walkers in a conventional machine indicates system overload, while no grain near the bottom indicates excess capacity. Feed rate may be increased.

Returns and clean grain augers can be examined for the amount and quality of the material. Examine material on the sieves and in the returns to develop a sense for how much straw breakup is occurring with the current settings. The operator's manual and troubleshooting techniques provide guidance on whether the machine is operating as expected or requires adjustment. Following the examination, and noting anything to adjust, all shields and access doors are replaced. Use the manufacturer's recommended procedure for restarting a loaded machine.

Software for understanding interactions between adjustments

Perhaps the aspect of combine operation and adjustment that is most challenging is the interaction of the many possible adjustments. Few things can be changed on a combine without influencing other things. While it is possible to describe many of these situations, it is sometimes easier to see the effects graphically. For example, Figure 28.5 shows the effect of forward speed on losses from the cylinder, cleaning shoe, and separator system. Clearly, pushing the machine speed in an attempt to speed the harvest can be counterproductive as losses increase dramatically with excessive loading.

A software application developed by Case IH can be useful for gaining a general understanding of the interaction of machine settings and operator controls on the combine performance. Figure 28.6 shows an image of the rotor, shoe, and fan of an axial flow combine. The program animates the components showing relative motion and the flow of material. At the top of the diagram, graph bars indicate performance measures such as losses, grain damage and engine load. Ideal performance is also indicated by the graphs. Below the machine animation are the machine settings and operator inputs.

The user can interactively increase or decrease any of these settings or inputs. The software will then indicate the likely impact of the change in setting on the six performance measures. In this way it is possible to see which performance measures are impacted by a change to the machine.

The tool is a quick way to consider the impact of a change to the machine or operating point. It may also help identify the unintended consequences of operating at an extreme of one input. The Case IH course on combine theory and settings, along with the dynamic simulator program, can be accessed at http://cell25.com/CaseIH/htmls/global/course.html

Windrowing

Minimizing harvest losses as the crop is cut and gathered will include a careful assessment of the crop condition. Videos for windrowing wheat are available at http://www.youtube.com/watch?v=GIbqW6Xhcmw. Some producers will have to decide between windrowing wheat (for additional information on windrowing, see Chapter 27) and cutting the crop straight.

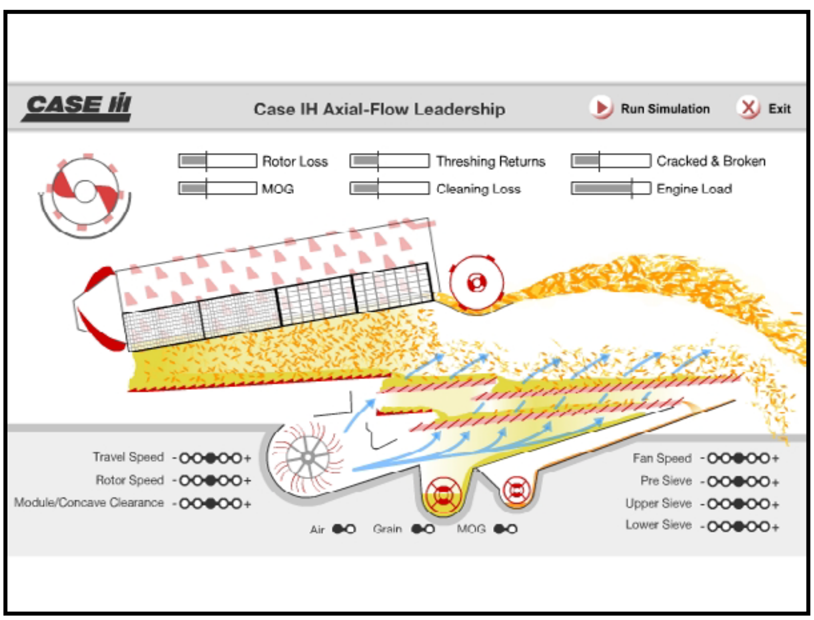


Figure 28.6. Case IH combine simulator illustration. Changing one or more of the operator adjustments at the bottom is reflected by corresponding changes in the performance measures at the top of the figure. (Source: Case IH website)

The crop condition that will most influence this decision is grain moisture content. Wheat with a moisture < 35% moisture is generally mature. Windrowing wheat when it is between 20% and 35% moisture will minimize shatter losses. Once moisture content falls below 20%, shatter losses from windrowing begin to rise (Figure 28.4), and this may favor allowing the standing grain to dry to storage moisture content followed by straight cutting.

Windrowing can be advantageous where excessive weeds are present, or when the crop has uneven ripening. It may also allow a slightly earlier harvest. Machine settings for the windrower to minimize shatter loss are much the same as for a combine head. The speed of the bottom circle of the reel should be slightly faster than the forward speed of the machine so that the grain stems are gently pushed back onto the cutter bar. Fixed bat reels should be adjusted in height so that the bats contact the crop stems just below the lowest heads of the crop. The centerline of the reel should be 6 to 10 inches ahead of the cutter bar.

The ideal windrow is of uniform depth and with a width equal to that of the feeder house on the combine. The ideal windrow will also have heads distributed evenly across the top of the windrow pointed toward the combine, and with some crisscrossing or weaving of the stems to give it some strength and resistance to settling in places where yields are light and the stubble is thin. Pickup rotational speed is critical to minimizing shatter losses as the dry windrow is taken into the combine.

The windrow should appear to be gently lifted up as the pickup moves underneath it. Excessive pickup speed, relative to combine speed, will begin to pull the windrow apart and strip grain from the heads in the process.

The process of determining losses when combining windrowed wheat is mostly the same as described earlier. It may not be possible to determine pre-harvest losses as any shatter losses occurring at the time of windrowing will also be observed at locations "A" in Figure 28.7. By backing the combine up and measuring losses at locations "B," it is possible to determine the total of pre-harvest plus windrow and pickup losses. Otherwise, the procedure for determining losses due to the internal parts of the combine is the same.

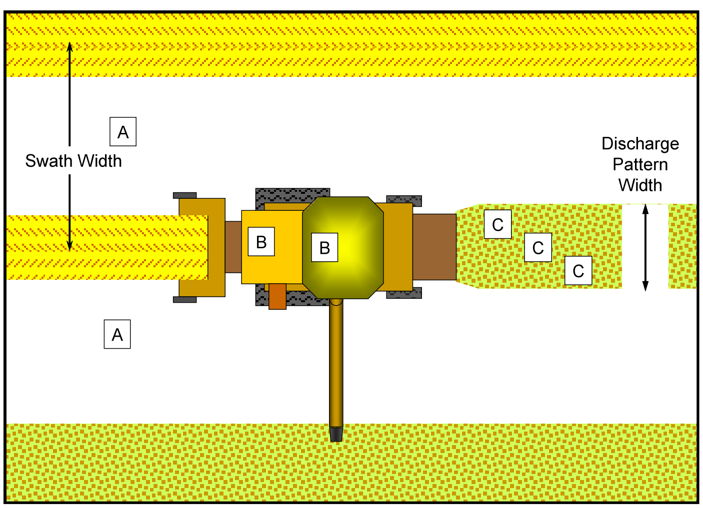


Figure 28.7. Locations for measuring field losses due to pre-harvest+windrower (A), pickup (B), and threshing, separating, and cleaning (C). (Illustration by Daniel Humburg)

Stripper heads

Combine stripper heads are effective in small grains, and under some circumstances can recover more grain than conventional heads and machines. Videos using stripper heads are available at http://www.youtube.com/watch?v=B0yjyiD5HdM&feature, or by searching for Shelbourne CVS Harvesting Wheat.

The stripper head uses a high-speed rotor in the head with a series of stripper plates to remove the grain or grain heads from the straw. The process acts like a comb which leaves most of the straw behind, but traps the heads and forces them off of the stem or to give up the grain within them.

A high proportion of the threshing takes place at the head as the impact of the stripper plates causes much of the grain to be dislodged from the heads at this point. Strippers take in only a fraction of the MOG compared to conventional machines. As a result, the threshing system and separator have a much smaller workload when using a stripper. The cleaning system, however, still must handle the full flow of grain. In fact the cleaning system may be the limiting component in terms of capacity for a combine operating a stripper head.

The process of measuring losses for a stripper head is the same as described earlier for a grain platform head. However, it should be expected that losses on the ground behind the head at locations “B” in Figure 28.3 may be higher. Since most of the threshing and separating occurs here, the losses from these processes will be here also. Threshing losses and separating losses from inside the combine are likely to be very small.

The main adjustment to the stripper head is the position of the front hood, which bows the grain stems forward and captures the grain that is pulled upward from the heads. It can be rotated forward or backward. The rotor speed is the other principal machine setting. Operator controls include the height of the head above the ground and the forward speed. Speed with stripper heads is much higher than with conventional heads, and they seem to work better at relatively high speed. As with conventional heads, the operator’s manual will have guidelines for adjustments to minimize losses and accommodate varying crop conditions.

Stripper heads have several advantages. First, since little straw enters the combine, the condition of the straw is not a factor and the machine is not troubled by tough, or damp, straw. Second, the crop can be harvested as soon as the heads and grain reach an acceptable moisture content. Third, strippers excel at recovering lodged grain.

A video clip of a Shelbourne head taking lodged wheat can be viewed at http://www.youtube.com/watch?v=cDV1aE0uuPo&feature.

The combs or stripper plates are able to rake lodged straw and capture heads from near the ground that are inaccessible to a conventional cutter bar and reel. However, stripper heads may not be as applicable in rough terrain where high vehicle operating speeds would be unacceptable.

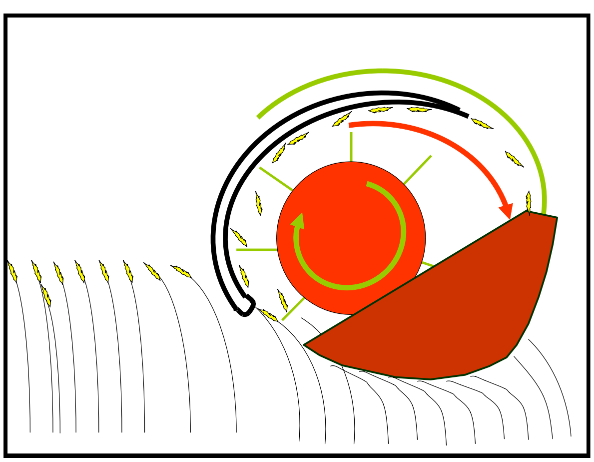


Figure 28.8. The stripper head concept. Straw is left in the field and grain heads are combed from the straw and captured under a hood onto the header platform. (Illustration by Daniel Humburg)

Summary

Growers interested in minimizing their harvest losses can do so by taking the time to measure the losses in the field. When grain losses are too high, the inefficient processes can be identified through careful analyses, and machine adjustments can be made to reduce these losses. Harvest loss tests should be done at the start of harvest and when changing from one crop to another, or when conditions change substantially.

Performing test like the Kill Stall can also build a better understanding of the interaction of machine settings with each other and with crop conditions. Once the combine is appropriately adjusted, it may only require occasional checks of losses. Also, upon achieving a well-tuned combine, the loss monitors can help identify when conditions change sufficiently so that another check of losses and their sources should be conducted. Minimizing losses is well worth the time spent as most producers have a goal to harvest the most wheat possible in a field rather than finish the quickest (see Harvest Loss Check Form on next page).

Harvest Loss Check Form for Wheat

Field Identification: ______________________________

Variety: ______________________________

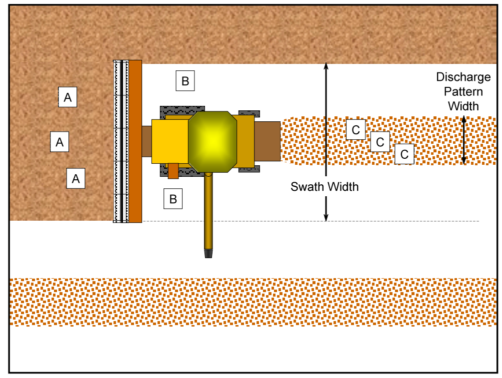
Condition of crop: ______________________________

Concave setting: ______________________________

Rotor Speed: ______________________________

Fan Speed: ______________________________

Combine forward speed: ______________________________



Other machine settings

Swath or header width ______________________ W_{swath}

Discharge pattern width ______________________ $W_{residue}$

Kernel Counts Per Square Foot at Sample Locations

Sample Location	Sample #1	Sample #2	Sample #3	Sample #4	Sample #5	Average at Location
A						=Aavg
B						=Bavg
C						=Cavg
*C found in heads						=C*avg

Pre-harvest Loss (bu/a)	A_{avg} /22	
Header Loss (bu /acre)	$(B_{avg} - A_{avg})$/22	$=H_L$
Threshing Separation & Cleaning Loss (bu/acre)	$[(C_{avg} - B_{avg}) \times W_{residue} / W_{swath}]$ /22	$=TSC_L$
* Threshing Loss (bu/a)	$(C^*avg \times W_{residue} / W_{swath})$ /22	$=T_L$
Total Machine Loss (bu/a)	$H_L + TSC_L$	$=M_L$
Indicated Yield from combine monitor or measured yield		=Y
% Machine Loss	$M_L / (M_L + Y) \times 100\%$	
% Header Loss	$H_L / (M_L + Y) \times 100\%$	
% Separator/Cleaning Loss	$(M_L - T_L) / (M_L + Y) \times 100\%$	
% Threshing Loss	$T_L / (M_L + Y) \times 100\%$	

Grain Damage ____________________ Straw condition ____________________________

Foreign Matter ____________________

Additional information and references

Case IH. 2010. CASE IH axial flow combine operator's manual. 3rd Edition, Print No. 84298546. CNH America LLC. Manuals can be purchased at Case IH dealerships.

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