FIGURE 1 - An NDSU study indicates the major portion of grain harvesting losses results from shatter before the grain gets into the machine.

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Grain Harvest Losses

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GRAIN HARVEST LOSSES - HOW MUCH CAN YOU AFFORD?

Harvesting is one of the most important farming operations. Grain loss at harvesting time is a direct loss of income. The more grain saved, the greater the returns.

A grain harvest loss study at NDSU indicates that **NOT** getting the grain into the machine produces the major portion of harvest losses. Improvement in operator performance can have a greater effect on reducing harvest losses than will new combine designs.

Combine losses can be due to improper operation and machine adjustment. Therefore, a thorough knowledge of the combine and its functions, and a desire to do the best possible job, are essentials for good combine operation. The first step to an efficient combining operation is a thorough study and understanding of the operator's manual.

GRAIN LOSSES

Grain harvest losses result from shattering of the standing grain, shattering during windrowing, picking up the windrow with the combine, and threshing, separating and cleaning in the combine. Estimates of acceptable losses for small grains such as wheat, barley and oats are placed at 3 percent of total yield. Total yield is harvested yield plus harvest losses. It is usually very difficult to reduce total losses below 1-2 percent so the operator must decide on how much crop loss he can afford. His decision will depend on the value of the crop, the cost of combining and the time available for combining or climate conditions. Some harvest loss is unavoidable in order to get a reasonably clean threshing job done in the time available.

Figure 2 indicates harvest losses of grain at various moisture ents. The curves indicate that as grain moisture content ases, losses increase. The curve labeled shatter, reel, cutter nd pickup loss indicates that if grain is windrowed at low moisture contents (below 20 percent), losses can be high. If grain reaches this stage of maturity, straight combining should be considered. It may be more profitable to harvest damp grain and dry it. The extra grain saved will usually more than pay for the drying.

In an NDSU study, harvest losses were divided into two categories: shatter-cutter bar losses and cylinder-separation or machine losses. Shatter-cutter bar losses include seed shattering from the standing grain, grain shattered during windrowing or straight combining and the grain lost in picking the grain up with the combine. Cylinder and separation losses include the grain lost by the combine from the straw walkers and cleaning shoe.

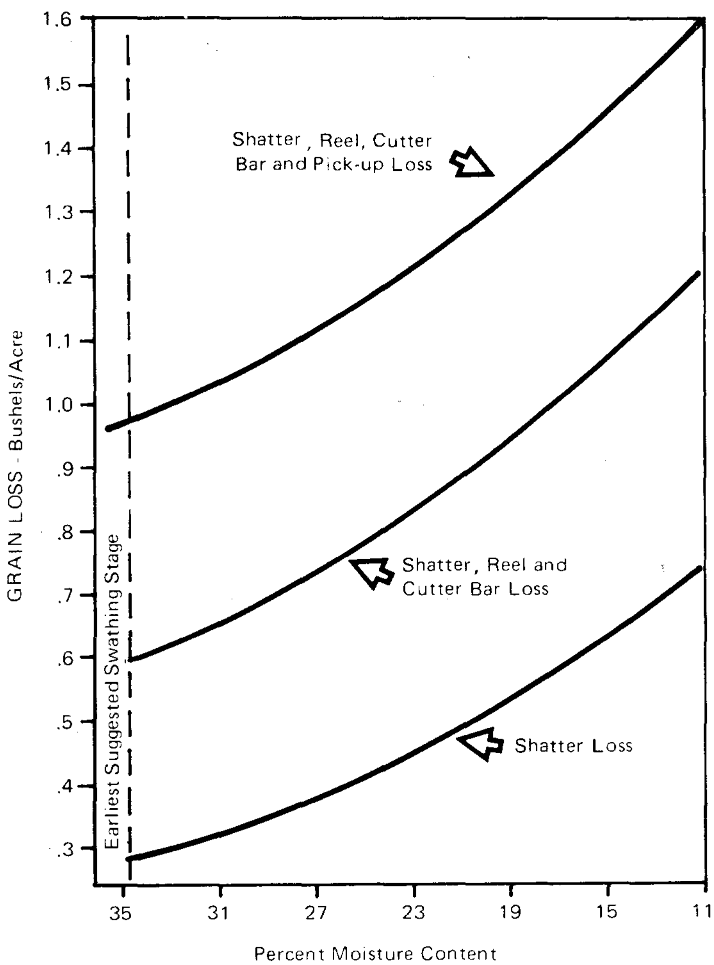
Loss studies show a considerable amount of grain is left in the field due to shattering out of the grain heads (Table 1). This can occur at several stages in the harvest operation. A considerable amount of grain is lost from the standing grain. A hailstorm on standing grain can shell heads, break them off and cause severe lodging problems. Wind can blow entire heads down or shell out a number of kernels. As the grain moisture content decreases, susceptibility to shatter and birds becomes greater. Some grain varieties are more shatter resistant than others. Cutting grain at moisture contents of 20-35 percent will help to avoid some of the shatter loss.

Random field checks show that combine operators are doing a good job of setting their combines to thresh and separate the grain. But more concern should be devoted to getting the grain into the machine.

From the test results, 60-80 percent of the total loss in harvesting spring wheat, durum and barley is due to shatter and cutter bar loss. In oats, the shatter and cutter bar loss about equaled the cylinder and separation losses.

Farmers usually adjust their machines to recommendations in the operator's manual for the particular crop to be harvested. In the field small adjustments should be performed according to field conditions. Operators often walk alongside the combine and catch the discharge from the cleaning shoe with a scoop shovel. This will give some indication of how much grain is being lost by the threshing and cleaning parts of the combine, but it will not give any indication of grain lost before it is picked up by the combine.

FIGURE 2 - Grain Losses in the Field at Harvest Time

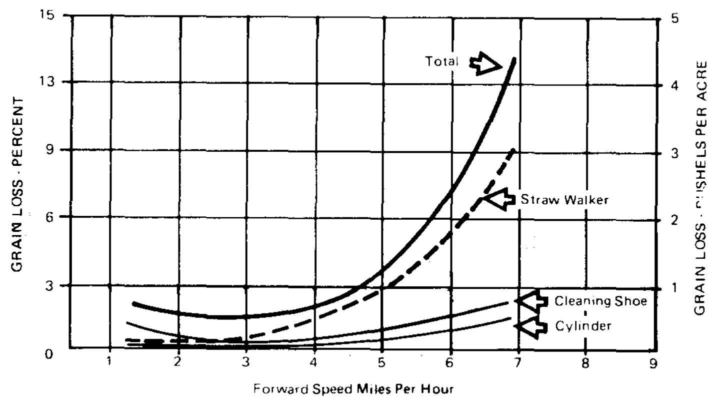


Adjusting windrow pickup speed to conform to ground travel speed and to pick grain up gently is important. Excessive pickup speed strips the grain out of the heads. A desirable speed is one that appears to gently lift the windrow as the pickup goes underneath. The windrow should be gathered in an unbroken, even flow to prevent shelling of grain before it get into the machine. A pickup drive that can be adjusted on-the-go is helpful for matching travel speed to windrow conditions. Excessive travel speed has been shown to be one of the chief causes of high losses from windrowing and picking up windrows. Travel speeds over 4 to 5 mph tend to cause excessive loss.

COMBINE OPERATION

Since it is difficult to save all the grain, a compromise is made between the speed of harvest and the amount of grain lost (Figure 3). Excessive losses can occur by delaying harvest as well as overloading the machine. If the operator wishes to harvest as quickly as possible, large losses may result due to overfeeding the machine even if the combine is properly adjusted. Losses of over 20 percent on a properly adjusted machine are possible, when combines are greatly overloaded. Total harvest losses are seldom, if ever, at zero.

FIGURE 3 - Typical Combine Performance



In the past, a common practice was to feed the combine until the engine started to slow down, then back off slightly on the feed rate. The best practice is to combine on the basis

TABLE I - Average Loss Results for Tested Crops in North Dakota

	1974 Hard Red Spring Wheat	1974 Durum	1974 Barley	1974 Oats	1975 Hard Red Spring Wheat	1975 Barley
Shatter and Cutter Bar (Bu/Acre)	.70	.66	1.13	.54	.98	2.57
% of Total Loss	65%	63%	63%	47%	82%	87%
Cylinder and Separation Loss (Bu/Acre)	.37	.39	.66	.60	.21	.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)	21.1	28.2	46.2	48.8	41.7	52.7
% of Crop Lost	4.8%	3.6%	3.7%	2.3%	2.8%	5.3%

of an acceptable field loss rather than the maximum the cylinder or engine will handle. Most combines have reserve engine power available beyond the usual maximum power required for normal threshing and separating. This extra power is needed for hilly conditions, soft fields and high moisture grain. The capacity of a combine is normally determined by its threshing and separating capacity.

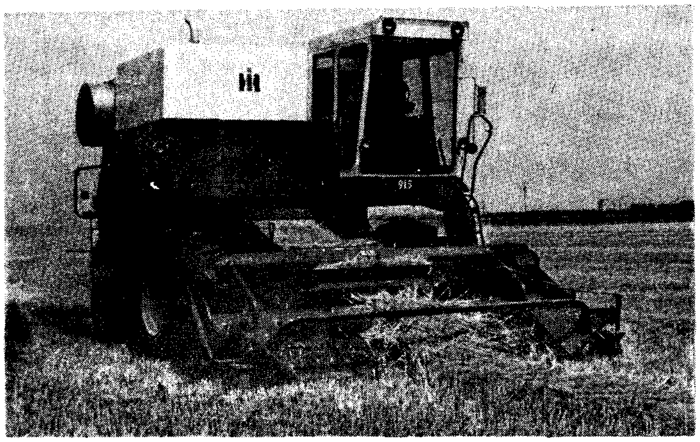


Figure 4 - The best practice is to combine on the basis of an acceptable field loss.

WINDROWING GRAIN

Windrowing grain at the right stage of growth is extremely important to reduce harvest losses. Whenever the grain moisture content is between 20 and 35 percent, there will be less total loss from windrowing. Harvest can usually be completed 3 to 5 days sooner by windrowing, as grain and weeds will dry faster and more uniformly in the windrow. At moisture contents below 20 percent, the total loss may be less by allowing the standing grain to dry to safe storage levels and straight combining unless weeds or uneven ripening are a problem.

North Dakota State University studies have shown that most small grains are mature at 35 percent kernel moisture content. At this stage of growth, wheat kernels are yellow without any trace of green and can be crushed between the fingers without finding any "milk".

Figure 5 - Windrowing grain helps to speed harvest. Grain should be cut at moisture contents of 20-35 percent. Below 20 percent, straight combining may produce less loss.

For best windrower operation, reel speed should be slightly faster than forward travel speed and the centerline of the reel placed 6 to 10 inches ahead of the cutter bar. A fixed bat reel should be run at a height with the lowest position of the bat slightly below the lowest heads. A good job of windrowing will help produce a good combining job.

The ideal type of windrow is one with the heads on top and distributed across its entire width. Some criss-crossing of the straw (herringbone pattern - Figure 6) is desirable to keep the windrow well up on the stubble. This is especially important when crops are light and may fall through the stubble. Windrows should be uniform without bunches and as wide as the combine cylinder and feeder if possible. This helps make efficient use of machine capacity.

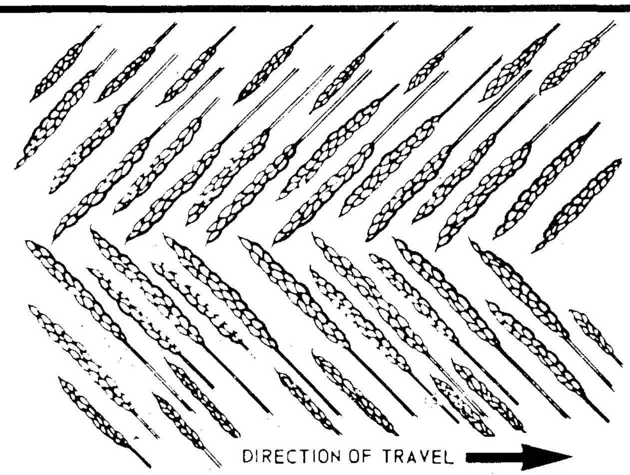


FIGURE 6. Heads-In-Line With Herringbone Pattern.

COMBINE MONITORS

Combine operator comfort is an important part of new machine design, so the operator has been placed inside an environmentally controlled cab. This isolates him from the dust and noise of combine operation but also reduces his ability to sense machine functions.

To overcome this problem, various types of monitoring equipment are available such as shaft monitors and grain loss monitors. Shaft monitors sense the rotation of drive shafts of machine components such as cylinder, straw walkers, elevators, fan and straw chopper. When the speed of any shaft drops below normal operating speed, a light flashes or buzzer sounds which indicates to the operator which area has a problem.

When a combine is operating properly, a large percentage of the grain is separated at the concave and the remainder at the walkers. When a combine is overloaded, less grain is separated at the cylinder and more must be separated at the walkers. Overloaded straw walkers can carry grain out of the combine. An overloaded or improperly adjusted sieve cannot separate the grain from the chaff. Grain loss monitors help the combine operator select the maximum ground speed that will maintain grain losses at or below an acceptable level. These units employ an impact detection system to measure the amount of grain going over the straw walkers and sieves. The use of a grain monitor can be compared to the speedometer in a car. The monitor is not a substitute for careful machine adjustments but is a good guide in selecting travel speed for varying conditions such as size of windrow and moisture conditions. A grain loss monitor must be calibrated to provide an acceptable grain loss reading. This is done by finding the loss in bushels per acre and comparing that loss to a reading on the grain loss monitor. If the combine is used on different crops, the monitor must be recalibrated to read an acceptable loss. Monitors are not only useful in limiting maximum speeds and losses, but can be used to properly feed the combine for optimum capacity.

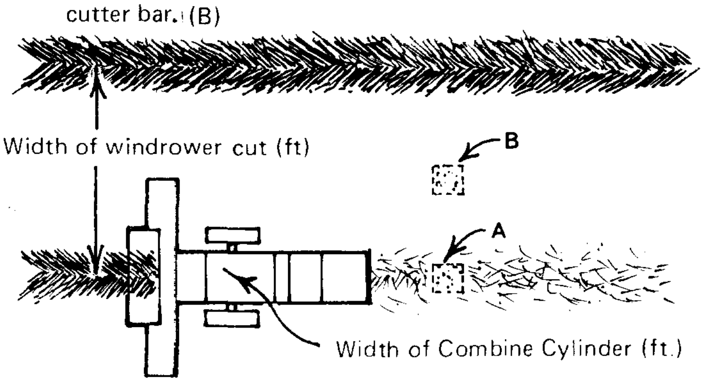
MEASUREMENT OF HARVEST LOSSES

Several different methods of determining harvest losses have been tried. Counting the seeds in a strip the entire width of cut is an accurate but time consuming method.

Figure 7 - A simple but accurate way to estimate harvest losses is count the number of seeds in 1 square foot in several places in the field.

A simple but accurate method to estimate losses requires the use of a one-foot square frame (Figure 7). Pick a typical area of the field after the combine has passed. The steps to follow are:

1. Count the kernels left directly behind the rear of the combine. Count several separate square foot areas. (A)
2. Count the kernels already in the field due to shatter and cutter bar. (B)



3. Subtract (B) from (A).
4. Divide the results of Step 3 by the ratio:
   $$\frac{\text{Width of windrower Cut (ft.)}}{\text{Width of combine cylinder (ft)}}$$
5. Divide the result of Step 4 by the number of kernels for the particular crop for one bushel per acre loss (Table II). This is the approximate machinery loss in bushels per acre.

TABLE II. Number of kernels per square foot equaling one bushel per acre loss.

Hard Red Spring Wheat	20	Oats	10
Durum	16	Sunflowers	3
Flax	100	Corn	2
Barley	14	Soybeans	4

6. To find total loss, add the count in (B) to the result in Step 4. This gives the total seed count from shatter, cutter bar and machine losses.
7. Divide the total seed count of Step 6 by the number of kernels for the particular crop for one bushel per acre loss (Table II). This will give the approximate total loss in bushels per acre.
8. For a percentage loss, divide the loss in Step 7 (loss in bushels per acre) by the total yield (harvest yield plus loss) in bushels per acre for the field.

$$\frac{\text{Loss}}{\text{Harvest Yield Plus Loss}} \times 100 = \%\ \text{Loss}$$

Example: A 20 foot windrower is used in a wheat field yielding 26 bu/acre, and the combine has a cylinder 4 feet wide.

1. A = kernels per square foot counted directly behind the combine = 59 kernels per square foot.
2. B = kernels per square foot to the side of the windrow. B = 4
3. B – A = 59 – 4 = 55 kernels per square foot.
4. Ratio: $\frac{\text{width of cut (ft)}}{\text{width of cylinder (ft)}} = \frac{20}{4} = 5$
   Divide 55 by 5 = 11 kernels per square foot.
5. Divide 11 by 20 (Table II) = .55 bu/acre = machine loss.
6. Total loss = "B" plus answer in Step 4.
   = 4 + 11
   = 15 kernels/ft^2
7. Divide 15 by 20 (Table II) = .75 bu/acre = total loss.
8. % total loss = answer in Step 7 divided by harvest yield plus total loss.

$$\%\ \text{loss} = \frac{\text{loss}}{\text{harvest yield plus loss}} \times 100$$

$$\%\ \text{loss} = \frac{.75}{26 + .75} \times 100 = 2.8\%$$

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