



Section 10

Harvesting, Drying and Storing Wheat

Sam McNeill, Doug Overhults and Mike Montross

Harvesting wheat grain in the 18 to 24 percent moisture content range has not been widely practiced by farmers in Kentucky. In a double cropping system, however, significant profit potential exists for earlier wheat harvesting because of the increased yields of the second crop. Many years of agronomy research in Kentucky have shown that in general, after June 7th, a week delay in planting soybeans decreases yields between 4 and 7 bushels per acre. For economic conditions in 2007, with average yields in both crops and moderate field drying conditions, total costs of the double-crop enterprise decreased about \$1 per acre before the June 7 harvest date but increased about \$5 per acre afterwards (Figure 10-1). This difference is largely due to soybean yield, which provides a large incentive to dry high moisture wheat. Other advantages for harvesting wheat early are fewer weather related delays and increased yields due to higher test weight and less shatter loss at the header during combining. A spreadsheet decision tool is available on the BAE website (www.bae.uky.edu) for calculating operating costs as crop and fuel prices change from year to year.

Figure 10-1. Cost trade-offs between drying wheat/planting soybeans early versus field drying/delayed planting with 2007 grain and energy prices (\$7.25 for beans, \$4.17 for wheat and \$1.40 for LP gas).

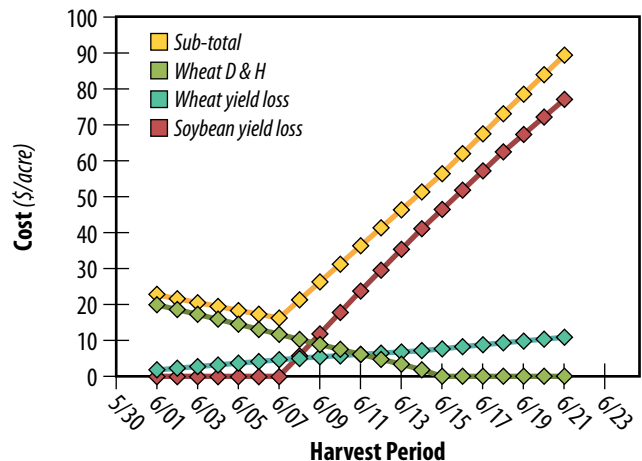


Photo 10-1. Wheat harvest is normally a very exciting stage of the wheat production process. (submitted by Joe Nichols, Seven Springs Farms)

Harvesting

Although wheat is typically harvested in the 13 to 15 percent moisture content range in Kentucky, it can be successfully harvested at higher moisture contents, provided it is dried quickly enough to prevent spoilage and/or sprouting. The moisture content at which harvest begins will depend heavily on the drying system available. Each farmer's goal should be to harvest as early as possible provided the grain can be dried safely. Some guidelines for matching the beginning harvest moisture content to the drying system are given in Table 10-1. If this is your first time to harvest high moisture wheat, start at a low moisture content and gradually increase it as you gain experience.

Drying System	Moisture Content (%)
High speed dryer	21 - 24
Bin dryers with heat/stirring equipment	17 - 20
Bin dryers without heat	< 17

When to Start?

Wheat harvest should begin as soon as the crop has field dried enough that it can be handled safely. A moisture meter is very useful to give a quick determination of crop condition. Most hand held meters are calibrated for corn or soybeans and have charts for converting readings to other crops. If a meter is not available, weigh a ¼-½ lb sample, dry it on a cookie sheet in a 260° F oven overnight (about 10 hrs), and re-weigh the sample. Calculate the moisture content by the following formula:

$$(wet\ weight - dry\ weight) / wet\ weight \times 100 = seed\ moisture\ (\%)$$

For example, if a 0.5 lb sample weighs 0.4 lb after drying, seed moisture is 20%:

$$(0.5 - 0.4) / 0.5 \times 100 = 20\%$$

Operating the Combine

The most important combine adjustments for harvesting wheat are cylinder speed, concave clearance, screen openings, and fan speed. Set the combine according to the manufacturer's recommendations before entering the field. Then, if necessary, adjust cylinder or fan speed in the field to improve threshing and cleaning. Lower cylinder speeds will reduce kernel damage. Increased fan speed will clean wet chaff more easily, but more grain may be blown out with the chaff. Be willing to dry some chaff if your drying system has adequate air flow.

Shatter at the header is the major source of wheat harvest loss regardless of the type of header that is used. One USDA study with a conventional cutter bar header showed that shatter losses were reduced in high moisture wheat. Researchers have observed that header losses increase as much as 1.7 bushels per acre as wheat dries in the field from 23 percent to 13 percent.

Header Choices

Limited studies have been conducted to compare the performance of rotor stripper headers and conventional cutter bars for soft red winter wheat. However, a recent report from the Northwestern United States for different types of wheat indicates that ground speed has more influence on header losses than the speed of the header rotor. Compared to a conventional cutter bar header, the stripper header had higher losses at low ground speeds but comparable losses as ground speed increased (Figure 10-2). Average losses for all ground speeds were 10.1 percent of total yield for the stripper header but only 5.8 percent for the cutter bar. As ground speed increased, header losses were nearly equal for both units.

Losses for the stripper header were also determined for various yield levels in this study and are shown in Figure 10-3. Losses generally decreased as yields and ground speed increased. Ground speeds that resulted in the lowest header losses for the stripper header were 2 to 5 times higher than those observed for the combine with the conventional cutter bar.

Check Harvest Losses

Measure field losses by counting loose kernels on the ground. Look in front of the combine in standing wheat to measure pre-harvest losses. Wheat kernels found under the combine are both pre-harvest losses and header losses. Count kernels behind the combine to measure total losses (pre-harvest, header, threshing, and separating losses). About 20 kernels found in a square foot area represent 1 bushel

Figure 10-2. Effect of combine and header rotor speed on wheat losses at the header.

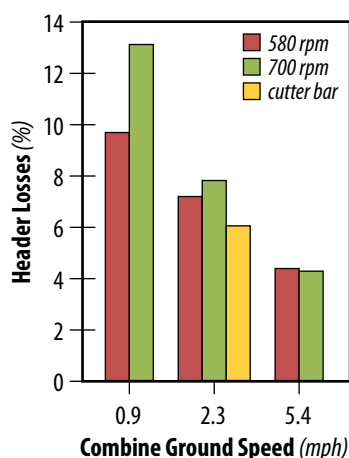
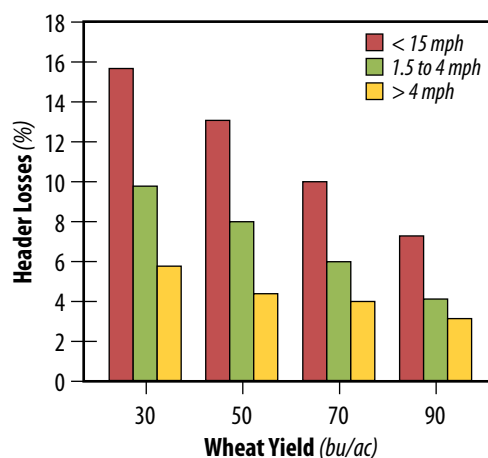


Figure 10-3. Effect of yield and combine speed on wheat losses at the header.



per acre loss. A good goal is to limit harvest losses to no more than 5 percent of the crop yield. Adjust ground speed, header height, reel speed and reel position to minimize harvest losses. Also, inspect cutter bars for sharp knives and replace dull ones when necessary.

Drying

Freshly harvested wheat grain should be dried to a moisture content of 14 percent or less within 48 hours to prevent sprouting and spoilage. High moisture wheat (>17%) can be dried with both high-speed and bin drying equipment. Corn drying systems can be used to dry wheat if some adjustments are made to maintain adequate air flow. The amount of water in a bushel of corn and wheat at different moisture levels is shown in Table 10-2.

Wheat has a higher resistance to air flow than corn, but there are usually fewer bushels to be dried. For commercial wheat, drying air temperatures should be below 140° F to avoid damage to milling quality. Seed wheat should be dried at 110° F or lower.

In-Bin Drying. Bin drying methods are easily adapted for wheat if adjustments are made to compensate for the increased resistance to air flow (measured as static pressure in inches of water). A rule of thumb is to limit wheat depth to half that used for corn. Centrifugal fans may be used to deliver higher airflow rates under higher static pressures. However, as shown in Table 10-3 for a 30-ft bin, wheat depths greater than 20 feet will generally reduce airflow rates to less than 1 cubic feet per minute for each bushel (cfm/bu) in the bin, even with up to three 15-hp fans.

Heat is required if bin drying wheat over 17 percent moisture content, as shown in Table 10-1. Stirring devices, recirculators, or automatic unloading augers can be used to increase capacities. Generally moderate air flows (2-5 cubic feet of air per bushel) and temperature rise (less than 20° F) are used. Excess heat can cause severe overdrying.

If high moisture wheat is to be dried and stored in the same bin, extra care is advised. If the initial moisture is 20-24 percent, use heat to dry the top layer below 17 percent before adding more grain. Several bins may be needed to dry a large crop. After drying to 17 percent, use unheated air to dry the wheat grain to about 15 percent. During

Table 10-2. Amount of water in a bushel of corn and wheat at various moisture levels (lb/bu).^a

Grain	Moisture Content (% wb)														
	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Corn	5.3	5.9	6.5	7.1	7.8	8.4	9.1	9.8	10.5	11.2	11.9	12.7	13.4	14.2	15.0
Wheat	5.8	6.4	7.1	7.8	8.5	9.2	9.9	10.6	11.4	12.2	12.2	13.8	14.6	15.5	16.4

^a Using a base moisture level and test weight of 15.0% and 56 lb/bu for corn and 13.5% and 60 lb/bu for wheat.

Table 10-3. Airflow and static pressure (SP) at different grain depths in a 30-ft diameter bin of wheat with a full perforated floor using 1-, 2- and 3- 15 hp centrifugal fans.

Depth (ft)	Bu.	1-15 hp fans			2-15 hp fans			3-15 hp fans		
		Airflow		SP	Airflow		SP	Airflow		SP
		(cfm)	(cfm/bu)	(in H ₂ O)	(cfm)	(cfm/bu)	(in H ₂ O)	(cfm)	(cfm/bu)	(in H ₂ O)
2	1,131	17,282	15.28	1.80	30,651	27.10	3.87	40,426	35.74	5.72
4	2,262	15,955	7.05	3.24	25,913	11.46	6.15	29,886	13.21	7.48
6	3,393	14,784	4.36	4.42	21,617	6.37	7.23	23,436	6.91	8.06
8	4,524	13,801	3.05	5.40	18,264	4.04	7.73	19,229	4.25	8.26
10	5,655	12,888	2.28	6.19	15,846	2.80	8.04	16,399	2.90	8.40
12	6,786	11,960	1.76	6.78	13,915	2.05	8.18	14,344	2.11	8.50
14	7,917	11,041	1.39	7.16	12,431	1.57	8.29	12,777	1.61	8.58
16	9,048	10,180	1.13	7.42	11,250	1.24	8.38	11,535	1.27	8.64
18	10,179	9,453	0.93	7.63	10,285	1.01	8.45	10,525	1.03	8.69
20	11,310	8,830	0.78	7.81	9,480	0.84	8.51	9,686	0.86	8.73

Source: FANS software from the University of Minnesota Department of Bioproducts and Biosystems Engineering (bbe.umn.edu/Post-arvest_Handling_of_Crops.html).

this period, run the fan continuously to provide a uniform moisture content. Run the fan only during low humidity hours to finish drying to around 13 percent moisture. This management scheme minimizes the amount of over-dried grain in the bottom of the bin. Table 10-4 shows the moisture content that soft red winter wheat will approach when exposed to the temperature and relative humidity levels shown. Moisture levels decrease with lower humidity and higher temperature conditions.

High-Speed Dryers. High temperature batch or continuous-flow dryers usually have excess capacity for wheat drying. These units typically have very high air flow rates, so supplemental heat may not be required for daytime drying when harvesting in the 18-20 percent moisture range. If heat is used, the drying air temperature can be limited by cycling the burner on and off or by changing the gas burner orifices.

A Word of Caution. Some in-bin corn drying systems are operated by filling the bin completely full within 2-5 days. Under no circumstances should you attempt to follow this practice in drying high-moisture wheat. Rapid bin filling works for corn only when temperatures and moisture contents are low enough to prevent spoilage. Outside air temperatures (and grain temperatures) are 20 to 40 degrees higher when harvesting wheat than during the fall corn harvest. In-bin drying of high moisture wheat should only be done as a layer-fill, batch, or continuous flow process.

Rapidly filling an entire bin with high moisture wheat is a sure route to spoilage.

Avoid Overdrying when Possible.

Drying wheat grain below the base market level of 13.5 percent wet basis should be avoided if the crop is sold at harvest. An estimate of overdrying costs for wheat (at \$4.00/bu) are shown in Figure 10-4. However, if the crop is held through the summer when average temperatures approach 80° F, wheat should be dried to 12.5 to 13.0 percent to keep conditions dry in the bin (<65% RH) and thereby prevent problems with mycotoxins and sprouting during storage (Figure 10-5). Consequently, this additional cost should be considered as a cost of storage and not directly attributed to drying, since it is usually recovered when the crop is sold.

Storage

Sanitation, aeration and monitoring are the watchwords to remember when storing grain during the summer months. Totally remove the old crop before placing newly harvested wheat into a bin. Thoroughly sweep the bin wall and floor (including under aeration ducts, if possible) to remove grain kernels that may contain insect larvae and mold spores. Apply an approved insecticide both inside and outside the bin to delay insect population development before placing wheat in the bin.

Aeration should be used to cool wheat after drying with heated air. To a small degree, aeration will control grain temperature if it starts heating during storage, but this may only be a short term solution to avoid further damage to grain quality. If heating cannot be controlled by running the fan, the crop should be moved to another bin (if possible) to break up hot

Table 10-4. Equilibrium moisture content (EMC) of soft red winter wheat at different temperature and relative humidity levels.

Temp. °F	Relative Humidity (%)									
	10	20	30	40	50	60	65	70	80	90
	Equilibrium Grain Moisture Content (%)									
35	7.3	8.9	10.2	11.3	12.3	13.4	14.0	14.7	16.1	18.2
40	7.1	8.7	10.0	11.1	12.1	13.2	13.8	14.4	15.9	18.0
50	6.8	8.4	9.6	10.7	11.8	12.9	13.4	14.1	15.5	17.6
60	6.5	8.1	9.3	10.4	11.4	12.5	13.1	13.7	15.1	17.2
70	6.2	7.8	9.0	10.1	11.1	12.2	12.8	13.4	14.8	16.9
80	6.0	7.5	8.7	9.8	10.8	11.9	12.5	13.1	14.5	16.6
90	5.8	7.3	8.5	9.6	10.6	11.6	12.2	12.8	14.2	16.3
100	5.6	7.1	8.3	9.3	10.3	11.4	12.0	12.6	14.0	16.0

Source: American Society of Agricultural and Biological Engineers Standard D245.4.

spots in the bin that usually cause the problem. Consider adding temperature cables to monitor conditions during storage and an automated controller for aeration fans to start cooling stored wheat below 60° F as soon as possible in late summer.

Check the condition of stored wheat once a week during warm weather to guard against deterioration from molds or insects. Run the fan for a few minutes to check for off odors from the grain pile. Lock out unloading auger motor switches before looking inside any bin to check for wet spots on the grain surface. Feel the top 6 to 12 inches of wheat to monitor temperatures and insect and mold activity. Insert plastic insect traps below the grain surface (being sure to secure them to a ladder or other structural member of the bin) to monitor insect activity and check them during weekly inspections to stay ahead of damaging populations. Always wear dust protection masks when cleaning bins as well as during an inspection. References from the UK Entomology Department are updated annually and provide more specific information on approved insecticide and fumigation recommendations for controlling insects in stored wheat (<http://www.ca.uky.edu/entomology/entfacts/ef145.asp>).

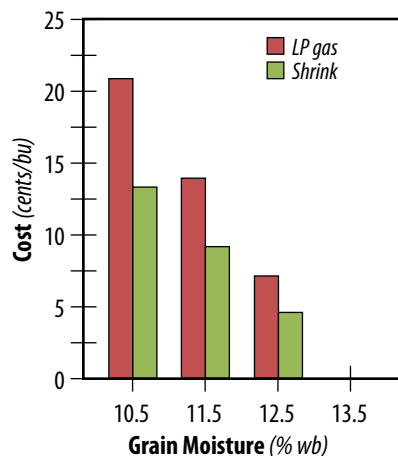


Figure 10-4. Cost of storing wheat below market moisture level (at \$4.00 per bushel and \$1.40 per gallon for liquid propane (LP)).

Figure 10-5. Equilibrium moisture content (EMC) for soft red winter wheat at various temperature and relative humidity levels.

