A2665

Harvesting and Drying Soybeans

Orrin I. Berge

Even though soybeans are mature when their moisture content is still well above 20 percent, you cannot successfully harvest them until the plants have died. Since seed damage and harvest loss increase as moisture content decreases, it is desirable to harvest as soon as possible. If the moisture content drops below 13.5 percent, as it often does during good harvest weather, you should harvest the soybeans promptly. Soybeans which once dry below 13.5 percent and are re-wetted by rain tend to have a higher percentage of cracked seed coats when harvested.

SOYBEAN LOSS DURING HARVEST

Several factors combine to affect soybean loss during harvest. Harvesting procedures, of course, have no effect on preharvest loss, but are directly related to shatter loss, loose stalk loss, lodged stalk loss, stalk loss, stubble loss, and threshing loss. To reduce this total loss, you should measure these types of harvest loss and make the necessary combine adjustments to reduce them.

HOW TO MEASURE LOSSES

Make a rectangular frame that encloses 10 square feet and is equal to the width of the header. You can do this easily by using a plastic clothes line taped to four metal pins of No. 9 wire.

Header Width	Frame Dimensions
8 ft.	8 ft. x 15 in.
10 ft.	10 ft. x 12 in.
12 ft.	12 ft. x 10 in.
13 ft.	13 ft. x 9¼ in.

Stop the combine at least 300 feet in from the ends of the field, at a place where the crop is typical. Back up 15 feet.

1. **Total crop loss.** Place the frame across the harvested swath at the rear of the combine. Count the beans within the frame area and divide by 40 (four beans per square foot equals one bushel per acre). If this loss is about 3 percent of yield, continue harvesting. If it's greater, you should try to determine why.

2. **Preharvest loss.** Determine this by putting the frame down in the standing beans, counting the beans on the ground, and dividing by 40.

3. **Machine loss.** Subtract preharvest loss from total crop loss.

4. **Header loss.** Place the rectangular frame between the parked combine and the standing beans. Make the count as follows:

   a. **Shatter loss.** Count all beans on ground and in loose pods on ground.

   b. **Loose stalk loss.** Count all beans in pods attached to stalks that were cut, but were not gathered into the machine.

   c. **Lodged stalk loss.** Count beans in pods attached to stalks that were not cut.

   d. **Stubble loss.** Count all beans in pods attached to stubble. Add **a, b, c,** and **d** to determine header loss.

5. **Threshing loss** (cylinder and separation loss). Subtract header loss from machine loss.

OPERATING THE COMBINE TO KEEP LOSSES LOW

1. Make sure the cutting mechanism—knife sections, guards, wear plates and hold-down clips—are in good condition and properly adjusted.

2. Operate the cutterbar as close to the ground as possible. (This is made easier if you have not hilled the soil around the plants when cultivating, thus keeping the seed bed level.)

3. Use a ground speed of 2.8 to 3 mph. To determine speed, count the number of 3-foot steps taken in 20 seconds while walking beside the combine. Divide this number by 10 to get the ground speed in miles per hour. A rate of 28 to 30 steps in 20 seconds should be about right for weed-free beans.

4. Use a reel tip speed about 1 1/4 to 1 1/3 times ground speed: a reel speed of 11 rpm per mph for a 42-inch diameter reel or 33 rpm per 3 mph.

COOPERATIVE EXTENSION PROGRAMS
University of Wisconsin—Extension
University of Wisconsin—Madison

FACT SHEET
OCTOBER 1974

5. Set the reel shaft 6 to 12 inches ahead of the cutterbar and just low enough so the reel leaves the beans as they are cut.

6. Use a six-bat reel—it feeds plants into the cutterbar uniformly.

7. Use a cylinder speed of about 500 rpm, adjusting plus or minus 50 rpm as conditions warrant. Leave a front concave clearance of 5/8 inch to 3/4 inch and a rear concave clearance of 1/4 inch to 3/8 inch. You may set the chaffer opening at 5/8 inch to 3/4 inch and the sieve at 1/4 inch. You should adjust the fan speed and air blinds to keep the lighter chaff moving without blowing beans over.

EFFECT OF CUTTERBAR TYPE ON LOSSES

An Illinois study shows that the floating cutterbar is an effective device to reduce cutterbar losses. The automatic finger height control alone is somewhat less effective, but the two in combination result in slightly reduced stubble height. See Table 1.

Table 1. Soybean Harvest Loss as Affected by Combine Header Control.[1]

Type of loss	Finger Height Control	Floating Cutterbar	Floating Cutterbar and Finger Height Control
	percent	percent	percent
Preharvest loss	2.22	1.53	1.95
Shatter loss	3.59	3.91	3.70
Stubble loss	.19	.07	.03
Lodge loss	.11	.01	.06
Stalk loss	2.59	1.59	1.91
Total header loss	6.48	5.59	5.70
Threshing loss	.30	.56	.51
Total loss	9.00	7.67	8.16
	bushels	bushels	bushels
Total yield per acre	49.57	50.27	49.9
	inches	inches	inches
Stubble height	3.49	2.42	2.18

[1] Percent loss is based on the percent of total yield and is an average of data from Hark, Beeson, and Calland Varieties.

DRYING SOYBEANS

Difficulties with harvesting soybeans in 1970 and 1972 have led to increased interest in artificial drying.

Basically, all grain drying methods are adaptable to soybeans, with some restrictions on the use of heat and handling practices to reduce seed coat splitting. The ideal air distribution system is a perforated floor under the grain as is used for corn drying. However, duct systems, if suitably designed, will also do an excellent job.

Studies by Ohio State University agricultural engineers indicate that to avoid seed coat cracking, it is important to keep the drying air above 40 percent relative humidity.

A useful rule of thumb is that relative humidity of the drying air is cut in half with each 20° F temperature increase. Thus, if the relative humidity is 80 percent and the natural temperature 50° F, to keep the humidity above the 40 percent minimum level, you can raise the temperature to no more than 70° F.

You may use unheated air if the natural air conditions are above 60° F and the relative humidity below 70 percent. If the weather is colder and damper, a drying operation with unheated air is useless.

A safe and easy way to add heat is to use an oversize drying fan and motor connected to an undersized distribution system. The added heat due to air turbulence and waste heat from the motor can produce a temperature rise of 3° to 10° F, which can help tremendously.

You may also add heat by placing an electric resistance heating element in the air inlet to the fan. Such a system will produce a 3.4° F rise in temperature for each kilowatt per thousand cubic feet of air. Thus, a 10-kilowatt heating unit would increase the temperature 3.4° F for a 10,000 cfm fan.

You may also use the usual LP gas heater and fan combination, if you can hold the temperature to no more than a 20° F rise.

You should not dry soybeans for seed at a temperature exceeding 110° F or germination may be seriously damaged.

In most crop drying processes, approximately 2,000 Btu of heat are required to evaporate a pound of water. Thus, to dry beans from 18 percent moisture content to 11 percent, 5.1 pounds of water per bushel must be removed. This will require 2,000 times 5.1, or 10,200 Btu per bushel of beans dried.

Table 2. Amount of Water in a Bushel of Soybeans at Various Moisture Contents.

Percent Moisture Content	Pounds of Water /Bu* Soybeans	Excess Water in Pounds Dried to 13%	12%	11%
24	16.5	8.7	9.4	10.1
22	14.7	6.9	7.6	8.3
20	13.1	5.3	6.0	6.7
18	11.5	3.7	4.4	5.1
16	9.9	2.1	2.8	3.5
14	8.5	.7	1.4	2.1
13	7.8	0	.7	1.4
12	7.1		0	.7
11	6.45			0
10	5.8			

* The weights per bushel in this table are based on a bushel of grain at 13% moisture content.

Another useful rule is that Btu per hour equals air flow (cfm) times temperature rise (F). Thus, with an air flow of 3 cfm per bushel and a temperature rise of 20° F, the heat input is 60 Btu per hour per bushel, and a bushel would dry from 18 percent moisture to 11 percent in approximately 170 hours or seven days.

In general, static pressures required to force air through soybeans are approximately 25 percent less than for shelled corn. See Table 3.

Table 3. Static Pressures Required to Force Air Through Soybeans.

Air Flow Per Bushel	Depth of Soybeans—Feet						
	1′	2′	3′	6′	8′	10′	12′
CFM	Static Pressure in Inches of Water*						
2				0.5	0.8	1.2	1.5
3				0.7	1.2	1.9	2.5
4				1.0	1.7	2.7	4.2
5				1.3	2.2	3.8	5.3
20	0.3	0.7	1.7				
30	0.4	1.2	3.0				
40	0.5	1.7	——				
50	0.6	2.3	——				

* Static pressure includes 0.25 inch for duct friction loss.

You can determine what size fan you need on the basis of 1.0 horsepower per 3,000 cfm at 1 inch static pressure. The air delivered per h.p. decreases as the pressure increases. Thus, 1 h.p. equals 3,000 cfm at 1 inch; 1 h.p. equals 1,500 cfm at 2 inches; and 1 h.p. equals 1,000 cfm at 3 inches. (If you need more information on determining static pressure, or instructions on how to build your own static pressure gauge, consult publication A2182, "Building Ventilation Indicator.")

FIGURING THE COST OF DRYING SOYBEANS

As stated in an above example, if the air flow is 3 cfm per bushel and the temperature rise is 20° F, and if the heat input is 60 Btu per hour per bushel, a bushel of soybeans would then dry from 18 percent moisture content to 11 percent in approximately 170 hours.

You can estimate the horsepower requirement from grain depth, air flow, and static pressure. Thus, at 3 cfm per bushel and 10 feet bean depth, static pressure will be 1.9 inches.

$$\text{h.p.} = \frac{\text{cfm x static pressure}}{3{,}000}$$

For 1,000 bushels, cfm = 3,000

$$\text{h.p.} = \frac{3{,}000 \times 1.9}{3{,}000} = 1.9 \text{ h.p. per 1,000 bushels}$$

Estimating operating cost at 1 kilowatt hour per h.p., and $.02 per kilowatt hour, the operating cost for power for 170 hours would be:

1.9 x 170 x $.02 = $6.46 per 1,000 bu = $0.006/bu.

Assuming all the fan energy input is converted to heat, and figuring 10,200 Btu per bushel, all supplied by electrical energy at $.02 per kilowatt hour, the electrical energy cost per bushel equals:

(10,200 ÷ 3,414 Btu per kilowatt) x $.02 = $.059 per bu.

You can estimate the annual fixed cost per bushel on the basis of 17 percent of the investment cost per bushel in bin components used for drying (perforated floor, fan, motor, heater, wiring, and controls). If you can build the system with an investment of $.50 per bushel, the annual fixed cost becomes: $.50 x .17 = $.085.

The cost of drying is the sum of the fixed and operating costs and equals approximately $.144 per bushel.

STORING SOYBEANS

You should manage soybeans in storage like any other grain with regard to cooling and aeration.

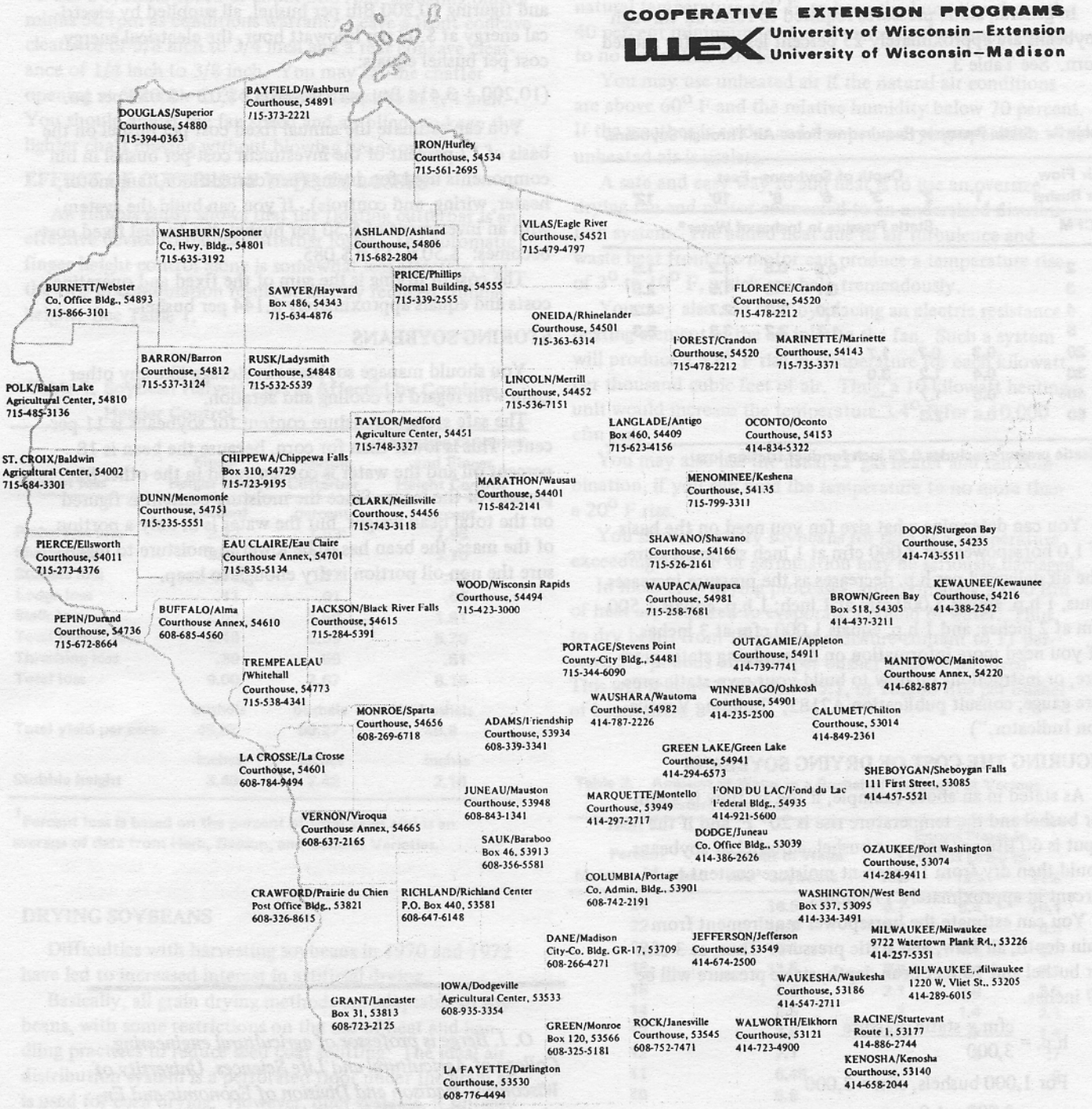
The safe storage moisture content for soybeans is 11 percent. This is lower than for corn, because the bean is 18 percent oil and the water is concentrated in the other 82 percent of the mass. Since the moisture content is figured on the total bean weight, but the water is in only a portion of the mass, the bean has to be lower in moisture to make sure the non-oil portion is dry enough to keep.

O. I. Berge is professor of agricultural engineering, College of Agricultural and Life Sciences, University of Wisconsin–Madison and Division of Economic and Environmental Development, University of Wisconsin–Extension.

COUNTY EXTENSION OFFICES

In every Wisconsin county, University of Wisconsin—Extension faculty members are ready to serve you with information and educational programs. Each has the key to research information and other resources of your University of Wisconsin system, the United States Department of Agriculture, and other federal agencies. You may contact University of Wisconsin—Extension faculty members at any office shown on this map.

COOPERATIVE EXTENSION PROGRAMS
University of Wisconsin—Extension
University of Wisconsin—Madison



University of Wisconsin—Extension, Gale L. VandeBerg, director, in cooperation with the United States Department of Agriculture and Wisconsin counties, publishes this information to further the purpose of the May 8 and June 30, 1914 Acts of Congress; and provides equal opportunities in employment and programming. This publication is available to **Wisconsin residents** from county Extension agents. It's available to **out-of-state purchasers** from Agricultural Bulletin Building, 1535 Observatory Drive, Madison, Wisconsin 53706. **Editors,** before publicizing, should contact the Agricultural Bulletin Building to determine its availability. Price five cents plus postage.