HARVEST ALERT

MICHIGAN STATE UNIVERSITY EXTENSION

FACT SHEET # 5 Fall, 1997

Harvesting and Handling High Moisture, Frost Damaged Grain

Roger Brook and Tim Harrigan, Agricultural Engineering Department, Michigan State University

Grain producers need to develop a strategy for harvesting high moisture, frost damaged grain. A reasonable, sound strategy can help to avoid costly on-farm losses as well as discounts at the elevator due to broken kernels, low test weight, and poor storability.

Establish A Harvest Strategy

Spot check each field to determine the apparent quality of the crop. Since the outside rows are atypical, walk through the field in a pattern. For example, walk in about 10 rows, then down 10 paces, over 10 rows, then down 10 paces until the field is thoroughly criss-crossed. An examination of the plants combined with the collection of ear samples will help to decide when and where to harvest first.

Frost damaged grain will often have a higher than normal moisture content at harvest. Your harvest strategy ought to focus on minimizing field losses and maximizing grain quality, rather than minimizing fuel costs. Relative to the price of corn, energy for drying is cheap!

Lodging and quality loss may be significant problems in frost damaged grain. Corn or soybeans that are at risk of serious lodging (due to the presence of ECB damage or rotted stalks) or quality loss (as may occur when pods split due to exposure) need to be harvested promptly. The field drying rate diminishes significantly as the weather cools, and field drying essentially stops by mid to late November. A strategy that combines timeliness of harvest with proper operation of equipment will go far to minimize field and harvest losses.

Iowa research data shows that as the fall season progresses, we cannot expect significant drying in the field. The exception here may be freeze drying if we wait for freezing weather. However, available information puts this at a 4-5% moisture loss.

Combining High Moisture, Frost Damaged Corn

The objective when combining corn is to remove all kernels from the cob without damaging the grain. The best time to harvest high moisture corn for feed is when the grain is about 24 to 28% moisture. As moisture increases above this ideal range, it is increasingly difficult to thresh all kernels from the cob without cracking the kernels. Preharvest preparation, field combine adjustments and patience will help put quality grain in the tank. The manufacturer's instruction book is a source of information on combine settings and should be referred to at all times.

Fields should be inspected the morning after the frost as soon as the plant has begun to thaw out. Options for handling fall frost-damaged corn depend on the plant stage when frost occurred. If the corn was frozen in the milk stage, grain yield will be low, and green-chopping or ensiling is the most viable option. If the corn was frozen in the dough stage, yields may be reduced by at least 50% and the test weight may be less than 50 lb/bu. Since kernel moisture will still be above 60%, the crop must be left to field dry, if whole-plant moisture content is too low for corn silage. During this period field losses will increase due to stalk breakage and ear molds. Begin combining after kernel moisture drops below 35%.

Preharvest inspection of the combine will help assure the best possible mechanical condition. Start at the corn head. Check for and replace worn or loose gatherer chains, snapping plates, stalk plates, feeder conveyor chain, drive chains and bearings. Also, check the threshing components and correct obvious problems: worn or bent rasp bars or concave, alignment of the cylinder concave (parallel with cylinder or rotor), and worn or loose drive belts or chains. Check the operator manual for the

suggested range of settings for cylinder speed, concave clearance, chaffer and sieve openings.

Fine-tune combine adjustments for best shelling and least cracking. Grain above 30% moisture can be difficult to remove from the cob and is easily cracked and damaged by over-threshing. Begin harvest with combine adjustments that would likely under-thresh a typical, lower moisture crop. Set cylinder or rotor speed near the low end of the suggested range, and set concave clearance near the widest recommended setting. Open the chaffer and sieve to the maximum recommended openings. Check with the combine manufacturer for machine-specific recommendations.

Poor shelling can be caused by too wide a spacing between the cylinder or rotor and concave, too slow a cylinder speed, or too fast a ground speed. Cracked corn in the tank can be caused by too fast a cylinder speed, or too narrow a concave spacing. Too much cob or foreign material in the grain tank can be caused by improper sieve adjustment or too low a fan speed. Check the trash discharged from the rear of the combine. Few kernels should remain on the cob and most cobs should be unbroken. Check grain quality in the grain tank; there should be few cracked kernels and little cob and foreign material in the grain.

Under-threshing may be caused by too slow a cylinder speed and too wide a concave spacing. To find the best settings for the field conditions, make one change at a time and check the results of these changes frequently. Since increasing cylinder or rotor speed is more likely to damage the grain than reducing concave clearance, first try to improve threshing action by closing concave clearance slightly. Harvest a small amount and re-check grain quality in the tank. If many cobs begin to split without the corn being shelled, open the concave a small amount and try increasing cylinder or rotor speed by 10 or 20 rpm. Check grain quality and repeat the process until the best grain quality is obtained. At high grain moisture you may have to accept, and strike a balance between, higher than normal grain loss from unshelled cobs and damaged grain.

The chaffer, sieve, and fan blast also affect grain quality in the tank. The sieve should be opened far enough to allow grain, but not larger debris, to drop through. If the sieve opening is too small, grain will move to the tailings return and kernel cracking from over-threshing will occur. With the chaffer and sieve at the maximum recommended openings, start with the lowest recommended fan speed and gradually increase fan blast until kernels begin to be blown out of the combine or into the tailings return. Then, reduce fan speed a small amount. This is the maximum acceptable fan speed. Next, begin closing the chaffer and sieve slightly until little foreign material is carried to the grain tank.

Combining High Moisture, Frost Damaged Soybeans

Fall frost-damaged soybeans are generally considered salvageable if the plants reach at least the R6 or full seed stage before a severe frost. At the R6 stage, soybeans contain about 70% moisture, compared to 40-50% moisture at physiological maturity (the R8 stage). Soybean plants lose moisture rapidly after maturity, drying to a harvestable level below 15% moisture in 5 to 10 days with good drying conditions. The drying rate of frost damaged soybeans may be reduced initially, but studies indicate that freeze-damaged soybeans mature and change color at least as early (and sometime earlier) as undamaged plants.

If the frost occurs when pods are still green or yellow, begin harvest as soon as the grain moisture drops to 15% to avoid excessive shatter loss. Research at the University of Wisconsin indicates that field losses approach 0.2 bushels per acre for each day of delay after soybeans first reach a harvestable stage of 16 to 18% moisture.

Proper reel adjustments help to keep soybean losses low. The speed of the pick-up reel should be 50% greater than the ground speed of the combine. For example, a 42 inch reel should rotate at about 12 revolutions per minute (rpm) for each 1 mile per hour (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. For soybeans above 15% moisture, the combine cylinder or rotor speed may need to be increased to properly thresh the tougher pods. The manufacturer's instruction book is a source of information on combine settings and should be referred to at all times.

Determine Crop Drying Needs

Electronic moisture meters are generally not reliable at moisture contents above 25%, unless they have been specifically calibrated for this range. Moisture readings can easily vary by 2 percentage points from the actual value. Check the sample with several meters to get an idea of the range of variability.

Harvest more silage: Beef and dairy farmers can reduce the need for drying by harvesting more whole-plant silage. The ideal whole-plant moisture concentration for ensiling corn in bunker (horizontal) silos and stacks is 70% in order to facilitate tight packing and air exclusion. This roughly corresponds to the early dent stage of development. Most upright silos should be

filled with 60 to 66% moisture forage to avoid seepage. The lower end of this range corresponds roughly to the beginning of the black layer stage of grain development.

There is no evidence of increased whole-plant drying rates following frost before maturity. The kernel milk-line will not be a useful guide to whole-plant moisture for corn frost-damaged at immature stages. Rather than guessing at plant moisture for this corn, use the microwave oven technique to monitor moisture content.

If you do not currently have silo storage capacity, you might consider hiring a custom operator who has a bag-packer to fill some silage bags. The cheapest silage storage option, but the one with greatest spoilage losses, is to build temporary silage stacks on a level, well drained site. Packing of the silage in the stack is important for excluding air, and promoting the ensilage process necessary for preserving the silage.

Harvesting soybeans as forage may be an alternative for frost-damaged plants. Studies conducted at the University of Wisconsin indicate that soybean forage is comparable in quality to alfalfa harvested in the first-flower stage. The optimum time to harvest soybean forage is when seeds have started to fill the pods and the lower leaves of the plant are just beginning to turn yellow (growth stage R6-R7).

Store and feed high-moisture corn if you have access to unused silo capacity. Older silos might need to have additional bands installed to withstand the grain pressure (contact a silo company for recommendations on silo bands). Shelled corn should be harvested at 25 to 30% moisture for storage as high moisture corn.

Economics of drying relative to moisture content: If you delay harvest, you are likely to lose more grain in the field due to lodging and field mold. A 9 cent per bushel increase in drying costs is comparable to an increased field loss of 3%, assuming the corn is priced at $3.00 per bushel. Relative to the price of corn, energy for drying is cheap!

High-temperature in-bin and column dryers are best for rapidly drying high-moisture corn from above 20-22% to safe storage levels below 15% moisture. Low and natural air drying systems are not recommended for moisture contents above 20-22%, unless the bins are layer-filled, or have additional airflow capacity.

As the drying time increases with high moisture corn, it becomes more susceptible to browning. This is not necessarily a problem for corn to be fed to livestock. However, it will be discounted at the elevator. Research indicates that exposure to drying air temperature above 200 degrees for time periods in excess of 2 hours will likely result in some degree of browning. For corn above 30% moisture, browning is likely to occur. If it does, then the drying temperature needs to be reduced to 180 degrees or less.

Use in-storage cooling or dryeration instead of in-dryer cooling to reduce fuel use and boost capacity of high-temperature dryers. In-storage cooling requires only a good, positive pressure aeration system in a storage bin. Corn is unloaded from the dryer hot and cooled slowly in the storage bin. Dryer capacity is increased 20 to 40% and about 1 percentage point of moisture is removed from the corn during cooling.

Dryeration involves unloading hot corn into a cooling bin that has a full-perforated floor and then keeping the corn hot for at least 8 hours before cooling is started. After cooling, corn is moved to a normal, aerated storage bin. Dryeration requires some extra grain handling and possibly an extra bin, but dryer capacity is significantly increased and about 2 percentage points of moisture are removed during cooling. Corn cooled in a dryeration bin is less susceptible to breakage than corn that is cooled rapidly in a dryer.

Fall frost-damaged corn should be dried to kernel moisture of 12-13% for long-term storage. If the corn is to be used for feeding purposes, or sold during the winter months, drying to 13-14% moisture should be sufficient. Overdried corn is safer for storage but it also has a much greater breakage susceptibility than corn delivered at 15% moisture.

High moisture soybeans can be successfully dried using current corn drying technology. Most research and extension information indicates that they can be harvested at 18% moisture. If heat is added to the drying air in a bin-drying system, limit the temperature rise to about 20 degrees over ambient, which will help maintain the relative humidity of the air above 40%. Relative humidity control will help minimize splitting and seed coat cracks during the drying process.

Some column dryers cannot maintain temperatures lower than 120 - 140 degrees. These temperatures are in the range where seed coat cracks can be expected. Soybeans can be dried using high temperature drying equipment without the burner turned on. Alternatively, a simple shield can be used to direct some of the moisture laden, exhausted drying air back into the intake of the fan to increase the humidity of the drying air. Observation of the beans leaving the dryer is the best indicator of good or bad drying air conditions relative to cracking.

Drying edible beans can be accomplished in a bin drying system designed for corn (normally 1-2 cfm per bushel of grain in the bin). Fill the bin only 1/4 full of beans. Add a heater that will heat the air 20 degrees above ambient. You now have a drying system that should finish drying in 24 hours. Since you will be putting only 4-5 feet of beans in the bin, consider loading the bin using a slow speed, portable auger put in through the side access door to reduce the drop height. Reduce the speed of the augers (including the underfloor auger) to 200 - 300 rpm to help minimize damage during handling.

Maintain A Good Storage Management Routine

Grain in storage should be between 30 degrees and 50 degrees to maintain quality over a period of time. Temperatures colder than 30 degrees are not desirable because of the likelihood of warm spells during the winter, which may lead to moisture migration and a moisture build-up in the surface layers of grain. Temperatures warmer than 50 degrees will promote insect and mold growth.

Remember that at this airflow rate it normally takes 400-600 hours of fan operation to completely cool grain to 35-40 degrees during the fall and winter months. The most common mistake is to stop the aeration fans before the cooling front has moved through the entire grain bulk. This leads to condensation and layers of spoiled grain. Always move the cooling front through the entire bin before shutting off the fan.

Grain temperature can be estimated by holding a good thermometer in the exhaust airflow. The temperature change will be complete when the exhaust temperature is nearly equal to the outside temperature. For upward airflow, check grain temperature about 6 inches down from the top surface of the grain. For downward airflow, check the air temperature as it leaves the fan. Be sure to check around the outside edge of the fan, and not near the center.

Inspection on a regular and continuing basis is important to detect any moisture build-up problems which will lead to a further decrease in grain quality. These problems most often appear in the top three feet. The keywords for action are LOOK, FEEL and SMELL. LOOK at how well the grain is supporting you and for moisture condensation on the roof. FEEL the grain for increases in moisture and temperature. SMELL for any off-odors, but be aware that the development of odors indicates that earlier inspections missed something.

Fall frost-damage corn should be managed and aerated in storage the same way as normal dry shelled corn. The important requirements are proper drying, correct aeration system design (providing a minimum of 0.1 cfm of airflow per bushel of grain in storage) and aeration at the right times. Expect more fines and trash in poor quality grain. Pre-cleaning before filling and coring the bin after filling add a safety margin. Wet, broken kernels and trash do not separate out as well as dry ones, and they can only be stored safely for a few hours. Rotary screen-type cleaners have adequate farm capacity, and are fairly inexpensive. They clean out large trash as well as fines. Perforated auger sections help, but they remove a relatively small percentage of the broken kernels. Be careful when feeding screenings. Toxins from mold development are usually more heavily concentrated in broken kernels and fine material than in whole, cleaned grain. Never feed moldy fines to dairy, poultry, swine, or young or pregnant animals.

Green soybean pods tend to move toward the outside of a grain bin upon loading. Since the airflow during aeration is generally too low to dry them, green pods tend to spoil and cake the walls. Soybeans should be stored at 11-12% moisture, and cooled to 35-40 degrees soon after binning to prevent quality loss.

Although soybeans killed at the R6 stage are worth saving for grain, the soybeans may not make U.S. No. 2 grade quality, due to high percentages of shrivelled green soybeans. Growers may want to consider non-traditional markets to increase the value of their crop.

One final word of caution: Storing grain that was of poor quality at harvest into the next summer is risky. Remember that grain quality can never be improved during storage. Keep poor-quality grain in separate bins from good quality grain. This gives more flexibility in terms of special management, feed mixing, and marketing options.