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Preparing for Grain Drying and Storage Season

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Grain market values are never constant. However, one thing that is constant is that producers receive a better price for high-quality grain than for poor-quality grain. Producers of high-quality grain must skillfully manage their grain crop from soil preparation to seed selection through planting, irrigation, weed control, cultivation and harvesting. If all of these steps are done properly, a high-quality grain crop can fill the wagons leaving the field. However, all of the months of input costs and hard work can be undone in a few short weeks by improper drying and storage. A key step often overlooked for proper drying and storage is the preparation that should be done before harvesting begins. A key principle of preparation is that it is essential to prevent harvested grain from becoming contaminated by mold and insects. Two main sources for insects are contaminated equipment and the area around bins where small amounts of old grain remaining from the previous year can become infested. Therefore, time spent by grain producers before harvesting to prepare their grain drying and storage systems to receive freshly harvested grain is highly valuable.

The objective of this fact sheet is to provide grain producers with preparation tips for equipment and processes that affect grain quality before, during and after the grain drying season. After all, the season is not successfully complete until the grain is delivered to the customer and payment has been made to the producer. The following tips were collected from literature as well as from experienced and successful producers. Not all of these tips apply to every situation, so producers should shape this advice to their own unique conditions.

Before the Drying Season Begins

- Clean harvesting equipment based on the operating manual before harvesting grain. Cleaning is one of the most important steps to prevent contamination of harvested grain. The goal is to start with clean harvesting, transporting and storage equipment and keep it clean through the season.

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- Test and adjust combine settings so the amount of fines in harvested grain and damage to the grain are minimized. Molds usually originate and thrive on fines and broken kernels. Removing these fines will reduce the risk of mold growth during storage. Fines also attract insects and can block airflow during drying and cooling, further increasing the risk of poor-quality grain.

- Harvest and manage contaminated/infected grain separately to prevent cross contamination of clean grain. If an area of a field appears to have severe mold issues, consider mowing or disking the affected area to avoid further development or contamination, and never mix this with clean grain as mold and insects can rapidly spoil all grain in the bin.

- Remove all of last year's grain from each bin and clean up remaining dust. Removal of all debris will reduce the chance for pest infestation. Lock out all equipment that could present a danger to workers cleaning the bin. Have workers wear a dust mask when vacuuming out or sweeping dust and take proper precautions to prevent grain dust explosions. Examples of common dust masks are N95, N99 and N100. The difference between an N95, N99 and N100 respirator is simply the filter's efficiency level (i.e., N95 provides 95% efficiency). Of these three efficiency levels, N95 is the most commonly used. Additionally, avoid dust clouds by good plant housekeeping and control the sources of ignition (i.e., high bearing temperature and belt slippage). If walking on stored grain is necessary, follow recommended safety procedures. A grain handler entering a grain bin should have a body harness tethered to a lifeline that is manned by at least two others outside the bin; one should be able to see the grain handler inside the bin while the second can get aid if necessary.

- Clean the inside and outside of bins by thoroughly removing all old grain, residue and dust. Appropriate personal protective equipment should be worn at all times by those involved in the bin cleaning process. The walls may be brushed, and a vacuum may be used to remove grain and trash from ledges, above doorways, cracks, crevices, ladders, fans, air intake ducts and exhausts, aeration ducts, beneath drying floors (if possible), grain sumps and augers and any possible place where grain or debris may be lodged. Fumigate under floors and ducts that cannot be cleaned if an insect infestation occurred previously.

- Inspect perforated drying floors for any damage that may result in interference with the unloading auger or stirring devices. Clean clogged perforations in the floor to make sure proper airflow is able to pass from the fan to the grain.

- Clean combines, trucks, grain carts, grain pits, augers and any other equipment that will contact newly harvested grain. Remove old or moldy grain, harvest trash, residue or anything that might introduce mold or insects into the harvested grain.

- Locate all personal safety equipment that may be used throughout the season and store it near the bins for easy access. Make sure all equipment parts are complete for assembly and operating properly.

- Inspect and test all powered equipment to ensure it is in good working order and perform any needed maintenance, calibration, repair or lubrication. Begin this process far enough in advance to allow for part lead times for unanticipated repairs.

- Ensure that all augers and fans are cleaned, lubricated and functioning properly before the season. Check to ensure the impellor and auger are able to rotate freely and in the proper direction (improper rotation direction may indicate electrical problems). Listen for potential bearing problems or rotational interference that may be caused by bent or warped housing, bird or rodent nests or clumps of spoiled grain. Examine fan screens, belts, chain guards, auger covers and safety shields to ensure they are properly installed and working. Operate the fan to determine if motor is functioning properly, rpm seems normal and air output is normal. All safety precautions should be followed when checking and repairing augers and fans.

- If gas heaters for drying are being used, inspect gas lines for integrity, test for leaks, check for proper gas flow and burn. Make sure that the gas flame is blue (indication of complete combustion) and not red or yellow (indication of wasting gas and money). Ensure spark plugs are operating properly along with safety features such as flame detectors and positive airflow assurance switches. Fill burner fuel tanks and schedule deliveries according to anticipated needs.

- Inspect all electrical wiring, contacts, switches, controls and breakers. Repair any exposed or damaged wiring and enclose electrical parts in secure conduit or housing according to local codes to prevent shorts and damage from aging, rodents or insects. It is obviously far better to discover electrical problems prior to harvest when there is time for repair than being unable to load the dryer with wet grain when a delay of only a day or so can result in spoiled grain. Also remember that just because the equipment worked properly a few months ago does not mean it will work when it is critically needed as rodents and insects (along with the weather) seem to have a strong preference for destroying electrical equipment.

- Test, inspect and repair any grain-monitoring equipment used during drying such as temperature and humidity cables and the control system.

- Remove old grain, debris or trash not only from equipment but also from around the grain bin area so rodents will not have a place to nest or insects maintain a presence. Sanitation in and around the storage complex requires constant attention and is very important for maintaining the value of your grain.

- Mow and clean up around bins to discourage rodents from residing near bins. Clearing away old equipment, brush, leaves, grass and trash can discourage habitation from insects and rodents.

- Inspect grain bin exhaust vents to ensure they are not clogged with birds' nests or other debris as clogged vents can reduce airflow through the grain resulting in slower than expected drying rates. Clogged exhaust vents can also cause fans to overly pressurize a bin, potentially resulting in structural damage.

- Inspect the bins for leaks or holes and seal any location where water, snow, ice, birds or rodents could enter the bin.

- Inspect outside of the bin for wind or other damage that may have changed the shape of the bin or roof. Any structural damage to the bin could worsen with loading/unloading and fan operation, so it is best to identify any damage prior to use.

- Examine the area around the bin for water pooling or drainage problems. If present, properly grade the area to prevent water from entering or pooling near the bin. Standing water can support insects and perhaps indicate water inside the bin. Standing water inside the bin or near an aerator fan intake can increase the humidity of the air entering the grain and cause rewetting.

- Inspect the ground around the bins that will support vehicles or equipment (especially the loading/unloading approach area) for potentially wet spots where vehicles could lose traction or sink into the ground during rain. Add and spread gravel if needed. It will probably rain at some point during harvest, and proactive repairs can be done quickly and prevent long and messy delays during critical loading operations.

- Ease access to the grain drying and storage equipment area by relocating any equipment or parts that may interfere with transport and operations. Proactively moving potential hazards before the hectic harvest and drying period begins may prevent an accident such as ruining a tractor, truck or grain cart tire by running over a stray part. Having to replace a tire at the wrong time can add delay and costs to an already busy and costly month.

- Identify any power lines or other utilities such as gas lines, water pipes and drainage ditches that have been added to the area since last season. Make sure added power lines comply with distance regulations. Ensure that these power lines will not interfere with grain auger or unloading operations. Ensure that all operators are aware of new obstructions and every precaution is taken to prevent accidents or damage to utilities or equipment.

- Consider establishing a drying management program with moisture monitoring and control system that include moisture sensors and modeling computer program. These management programs can maximize final grain quality while minimizing energy costs. For seed producers, the high germination percentage is an important feature to consider, and for grain consumers, the properties like color and flavor will be important. Consider calibrating the sensors routinely and monitor the system to assure that it is functioning properly.

- Perform a final inspection to make sure that the bins have been thoroughly cleaned and all other preparatory measures on the checklist have been completed before classifying a bin as ready to

receive the new crop of grain. A good guideline for determining if bins are sufficiently clean is that an inspector would not be able to determine which crop had been previously dried or stored.

During the Drying Season

- Calibrate your grain moisture meter against a commercial moisture meter to ensure it is performing properly.

- Continually monitor the grain moisture content in the field using a moisture meter to properly plan so you will harvest grain at the optimum moisture content. For example, consider harvesting wheat at 15%-18% moisture. This MC range minimizes harvest losses and combine mechanical damage.

- Prepare the Equilibrium Moisture Content (EMC) table or chart associated with your grain type. It is helpful to know the EMC corresponding to air relative humidity and temperature when making decisions to manage the drying process. Air temperature and relative humidity as well as your grain moisture content will determine if grain drying or wetting will occur. This relationship can help you decide when to add supplemental heat to the drying air and to what temperature to heat the air for optimal drying while preventing over drying. EMC charts are available online on websites such as https://www.ag.ndsu.edu/graindrying/publications-grain-drying-and-storage.

- As a brief example, Table 1 provides EMC values for long-grain rice. Assume you harvested rice at 22% moisture content, air temperature is 70°F and air relative humidity is 80%. If you turned the fan on and kept it on for a long time, rice moisture content will drop to 16.4%. Note that the EMC values can be different for different grains, so be sure to get the right table. It should be mentioned that the fan will warm the air about 0.7° for each inch of static pressure. This will affect ambient air relative humidity and the grain moisture content.

- Never store new grain on top of grain from a previous season to prevent cross contamination and possible insect infestations. The old adage "one bad apple spoils the barrel" is true here as well. It takes very little insect infestation to spread into the new grain.

- Apply the recommended minimum airflow rates (in CFM per bushel) for air drying rice as shown in Table 2 for different moisture contents.

- Operate fans solely for the purpose of quality control to minimize grain shrinkage.

- Store low-quality grain in separate bins to avoid lowering the quality of good grain. Mixing will occur as the grain is unloaded.

- Use recommended drying procedures for your specific type of grain and cool grain quickly to

Table 1. Long-Grain Rice Equilibrium Moisture Content Percent Wet Basis.

Air Temperature (°F)	Air Relative Humidity (%)						
	30	40	50	60	70	80	90
40	9.9	11.5	13.0	14.6	16.3	18.2	20.9
50	9.5	11.0	12.5	14.0	15.7	17.5	20.1
60	9.1	10.6	12.1	13.5	15.1	16.9	19.5
70	8.8	10.3	11.7	13.1	14.6	16.4	18.9
80	8.5	9.9	11.3	12.7	14.2	15.9	18.3
90	8.3	9.6	11.0	12.3	13.8	15.5	17.8
100	8.0	9.4	10.7	12.0	13.4	15.1	17.4

Table 2. Recommended Minimum Airflow Rates Based on Moisture Content.

Moisture Content	Airflow Rate
%	CFM per bushel
11% - 13%	0.5
13% - 15%	1.0
15% - 18%	2.0
18% - 20%	3.0

reduce the potential for insect infestations and to minimize the potential for moisture migration and condensation problems.

- When using continuous flow or batch, high temperature dryers, keep in mind that a few points of moisture will be removed during the cooling step.

After the Drying Season

- Store grain at recommended moisture content and temperature levels to provide the required storage duration desired based on Table 3. Grain storage at high moisture content and high temperature can lead to hotspot development, mold growth, mycotoxin development and grain spoilage in storage. Low moisture content and temperature storage increase allowable storage duration. Safe storage tables or charts such as Table 3 show the length of time rice can be stored before a 0.5% dry matter loss occurs. Dry matter loss (DML) is weight loss caused by molds, sprouting, insect damage and respiration. Researches stated that 0.5% DML could be reached before deterioration became visible enough to cause market grade to drop. Safe storage duration is accumulated over time and cannot be reversed.

- As an example of reading the safe storage period table, for rice stored at a temperature of 68°F and a moisture content of 15%, it is safe to store it up to 270 days provided the temperature does not exceed 68°F and moisture content remains below 15%.

- Carefully monitor moisture and temperature levels during storage and apply recommended grain management practices including aeration (typically 2/10 CFM per bushel airflow) to prevent moisture migration, rewetting of grain near the top of the bin and hotspot development. Also ensure grain being stored is as clean as possible, as grain with a higher percentage of foreign material and immature, broken and damaged kernels has a relatively shorter safe storage period.

- Clean grain with a seed cleaner to remove fines and broken pieces as this may reduce mold levels.

By providing sufficient safe storage time for your grain, you give yourself the option to hold grain until prices maximize.

Resources for Further Information

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Table 3. Safe Rice Storage Periods (Days).*

Rice or Wheat Temperature (°F)	Moisture Content of Rice and Wheat (% Wet Basis)										
	14	15	16	17	18	19	20	21	22	23	24
86	40-120	20-30	8-15	5-8	3-5						
81	120-160	40-60	10-30	10-15	5-8	5-8	3-5				
77	160-240	40-120	20-60	20-30	10-15	5-15	5-8	5-8	3-5		
68	<270	80-160	40-120	40-60	20-30	10-20	10-15	10-15	5-10	5-8	5-8
59	>270	160-240	80-150	60-120	40-60	20-30	20-30	10-30	10-15	10-15	5-8
50	>270	>270	160-240	90-160	80-120	50-80	40-60	20-30	15-30	10-20	10-15
41	>270	>270	>270	<270	120-240	80-120	50-90	40-60	30-50	20-30	10-20

*It should be mentioned that these values assumed about 0.5% dry matter loss.

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