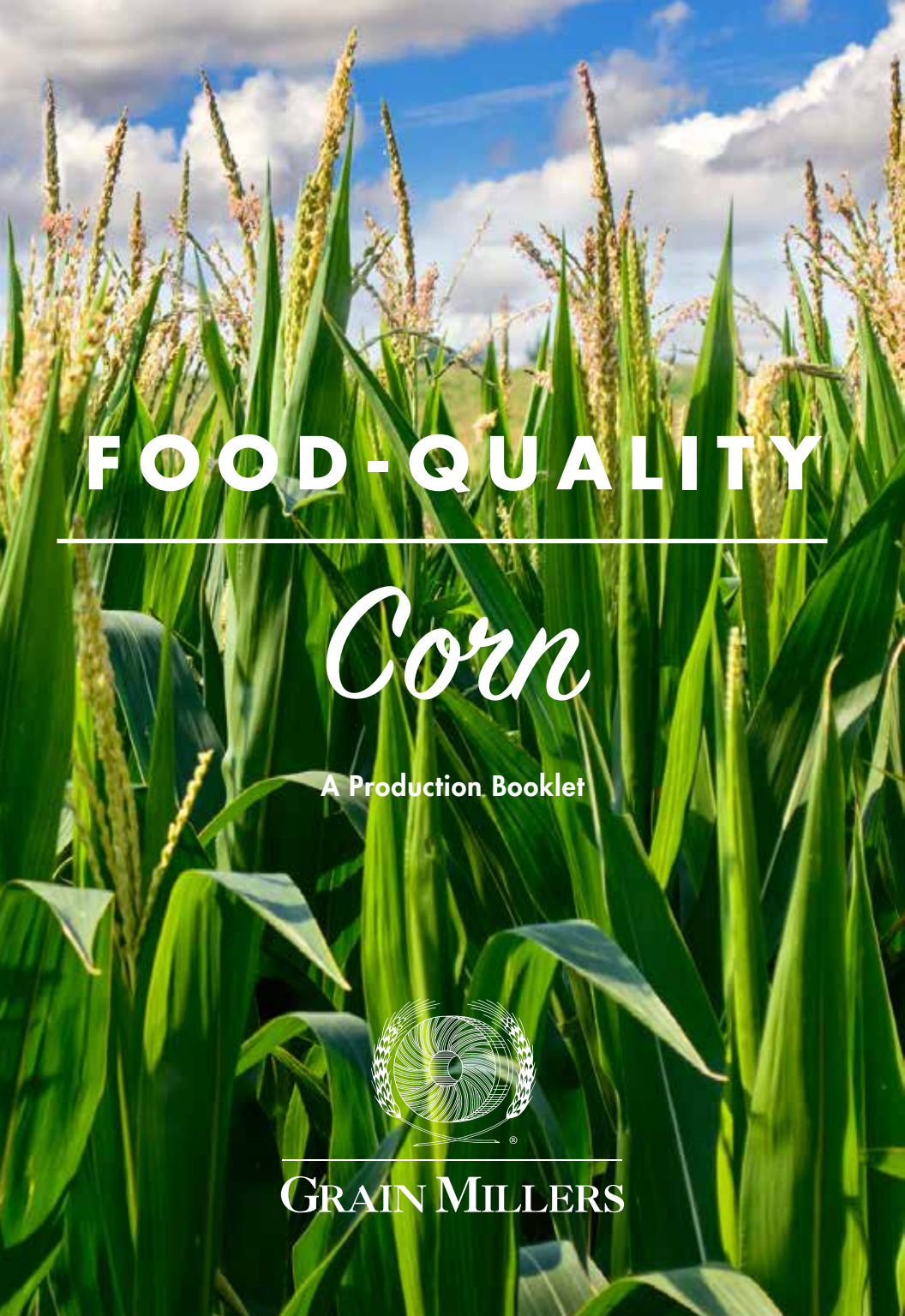


FOOD-QUALITY

Corn

A Production Booklet

GRAIN MILLERS

OVERVIEW

Since 1986, Grain Millers has been a leading manufacturer of whole-grain ingredients used in cereals, breads, bars, snacks, and many food products served around the world. Over the last 30 years we have experienced significant growth and expansion. This growth includes the creation of a food-grade corn business in 1992.

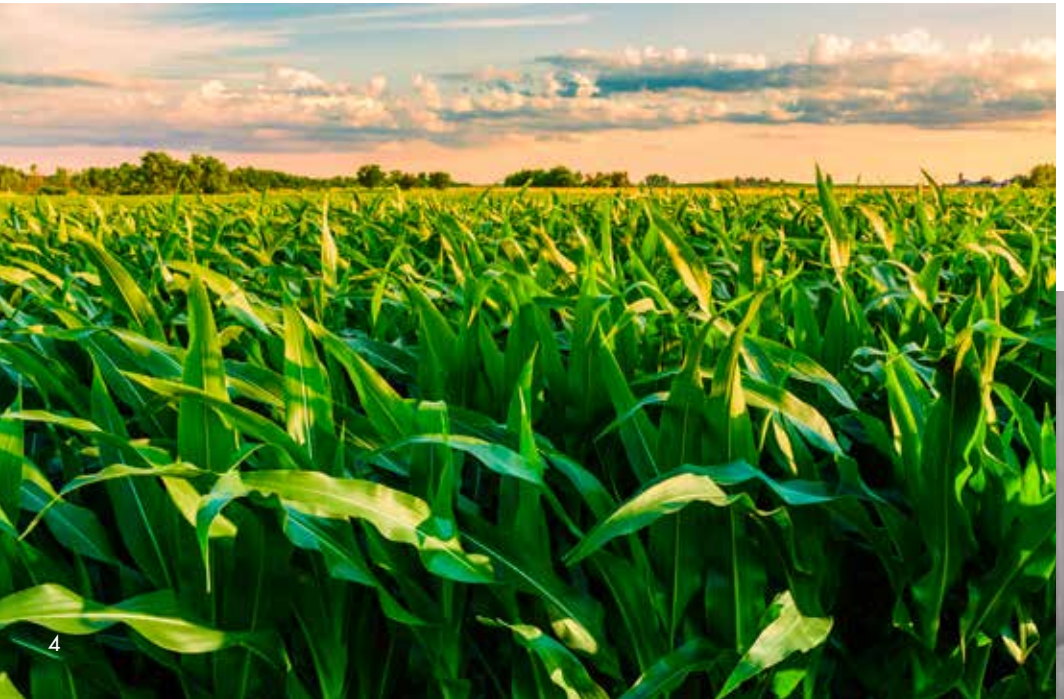
Food-grade corn is a grain that is destined to become an ingredient for human consumption. It is important that we buy "an ingredient" and not a commodity. This corn must be high in hard endosperm content; contain minimal stress cracks; and be a clean, high-quality product.

Over the years we have been approached by growers asking what needs to be done to produce high-quality, hard-endosperm corn for human consumption. In an effort to help growers meet these needs and the needs of other grains, Grain Millers introduced a Crop Sciences group in 2012. It is important that growers are able to produce the best crop and ingredient, this group is dedicated to helping farmers produce a crop of the greatest quality and quantity. This booklet is designed to be used as a resource for growers, to help them achieve these quality specifications and goals.

FIELD SELECTION

Field selection is a critical step for successful food-quality corn production. It is important to use fields with the proper crop rotation. Corn destined for food production should not be grown back-to-back with corn or other small grains that may harbor critical mycotoxins. It is best to grow food-quality corn on fields where legumes or cover crops were previously grown.

Get to know your neighbors and crop rotation plans for their fields that will be near your production fields of food-quality corn. To help protect maximum potential hybrid purity and final food-corn quality, it is important to know what neighboring fields will be producing in order to plan field isolation. This is discussed in more detail in the Harvest section of this document.



SEED SELECTION

Selecting high-quality seed is important for producing any crop. When looking at selecting seed for food production, a few factors become important for success. Proper selection starts by using the right hybrid for your field choice. Use Grain Millers' Corn Hybrid list to narrow down hybrids that are high in hard endosperm content and have both good agronomics and superior milling traits. Consult your seed dealer to make sure that the food-quality hybrid you are using has the right agronomics for your field choice. If questions arise during this process, be sure to contact your Grain Millers representative.

If the corn that is being produced for food quality is Non-GMO or organic, you need to be aware of the possibility of GMO contamination. As a Non-GMO Project Certified Miller, Grain Millers has a .9% limit on GMO contamination in corn that is being used for these markets. To help reduce the risk of high GMO contamination, be sure to select seed that has been tested for adventitious presence of GMO traits. Zero or low GMO contamination in the seed is needed to provide a product that can be used in the food industry. Talk with your seed dealer for more information on their testing procedures for seed corn, and inquire to see if they have conducted GMO testing on seed lots of hybrids that you are interested in purchasing.

DISEASE IDENTIFICATION

To prepare for the timing of your harvest, grain drying operations and grain handling and storage procedures, it is important to monitor the crop condition of your food-quality corn during the growing season. Many plant stresses can contribute to the development of plant diseases and mycotoxins that will affect crop yield and the food-grade quality and acceptability of your food-corn hybrid production. Weather stress, nutrient deficiencies, and insect damage can all play a part individually or collectively in the final yield and quality of your food-corn production.

Listed on the following pages are common corn ear-rotting diseases that will affect your final yield and quality of your food-corn production, and can ultimately affect the acceptability of your food-corn production with Grain Millers. Please familiarize yourself with these so that you can be aware prior to and during harvest. If you suspect one of these to be present in your food-corn production or have question concerning the identification or management of these diseases, please feel welcome to contact Grain Millers.

Diplodia Ear Rot

- Wet weather and moderate temperatures allow infection to occur if spores are present from early silk until 3 weeks after silking.
- Wet weather during grain fill, upright ears with tight husks promote the development of Diplodia.
- Tan spots on husks, bleached husks, or brown husks on green plants are outward symptoms for Diplodia.
- Fungal Infection starts at the base of the ear and moves towards the ear tip.

DISEASE IDENTIFICATION (continued)

- Reduced grain quality and yield due to smaller kernel size and lower test weight.
- Hybrid selection can be important for disease tolerance or resistance.
- Rotate corn fields out of corn for at least one year.
- Partial or complete burial of corn residue may provide some disease control. Potential Diplodia infection is highly dependent on the quantity of unburied infected corn residue.
- Clean grain after drying and before storing to remove lighter, damaged kernels, cobs, and fines.
- Monitor stored grain routinely for moisture content, grain temperature, and the development of storage molds.

Diplodia Ear Rot

DISEASE IDENTIFICATION (continued)

Gibberella Ear Rot

- Often a problem in the Northern and Eastern Corn Belt areas.
- Infection favored by cool, wet weather during and after pollination
- The fungus overwinters in the infected crop residue and spreads to the current crop by wind and rain splash.
- Identified by the red or pink color of the mold, starting at the ear tip, moving down towards the base of the ear.
- Early, severely infected ears may rot completely, with husks tightly adhering to the ear and mold growing between the ear and husk.
- Reduces grain yield, quality, and test weight.
- Grain storage life may be greatly reduced.
- Mycotoxins in the form of vomitoxin (DON) may develop, making the grain inferior or unsuitable for food, feed, or ethanol production.
- Hybrid selection is important for tolerance to this disease.
- Partial or complete burial of corn residue may provide some control.
- Scout fields before harvest – harvest infected fields early to limit disease development.
- Clean grain after drying and before storage to remove lighter and damaged kernels.
- Monitor stored grain routinely for moisture content, grain temperature, and the development of storage molds.
- Test for the presence of mycotoxins.

Aspergillus Ear Rot

- More common in hot and dry growing conditions during pollination and grain fill.
- Gray-green, olive, yellow-green, yellow -brown colored powdery mold growth on and in between kernels.
- Symptoms are often found at damaged areas on the ear.

DISEASE IDENTIFICATION (continued)

- Fungal spores become airborne and infect damaged kernels or grow down the silk channel when the silks are moist and yellow-brown in color.
- Damage to corn ears and/or kernels from wind, hail, or insects are avenues for infection.
- Mycotoxins (Aflatoxin) may occur with the development of the ear mold, although mold growth can occur without the development of mycotoxins.
- Reduces grain yield, quality, and test weight.
- Little if any resistance in hybrids at this time.
- Fungal spores overwinter in plant residues. Partial or complete burial of infected plant residue reduces disease inoculum.
- Limit damage from ear-feeding insects by using appropriate field treatments.
- Clean corn after drying and before going into storage to reduce broken, damaged, infected, lightweight kernels; foreign material; and fines.
- High concentrations of aflatoxin may be found in screenings, so dispose of correctly.
- Monitor stored grain routinely for moisture content, grain temperature, and the development of storage molds.


Gibberella Ear Rot


Aspergillus Ear Rot

DISEASE IDENTIFICATION (continued)

Fusarium Ear Mold

- Most common fungal disease on corn ears.
- Infection occurs over a wide range of environmental conditions, but is most prevalent in warm, dry conditions after silking.
- Infection occurs on scattered or groups of corn kernels.
- Appears as a white, pink, or red cottony mold and has a characteristic "starburst" streaking pattern on the kernels.
- Main point of entry is through insect damage.
- Ear rot severity is usually related to European Corn Borer, Western Corn Cutworm, and corn ear worm damage.
- Fungal spores survive on crop residue and can also overwinter on other grass crops.
- Airborne spores can germinate and grow down silk channels to infect the corn ear.
- Grain yields, quality and test weights are affected.
- In severe infestations, corn ears may be completely consumed by the fungus. Fusarium infections can produce Fumonisin – one of the most commonly occurring mycotoxins in the corn belt.
- Choose hybrids that have tolerance/resistance to Fusarium.
- Rotate infected fields out of corn production for at least a year.

Fusarium Ear Mold

DISEASE IDENTIFICATION (continued)

- Partial or complete burial of corn residue may provide some disease control.
- Limit damage from ear feeding insects by using appropriate field treatments.
- Clean corn after drying before going into storage to reduce broken, damage, infected, lightweight kernels, foreign material and fines. Monitor storage bins for moisture, grain temperatures and for the development of storage molds.

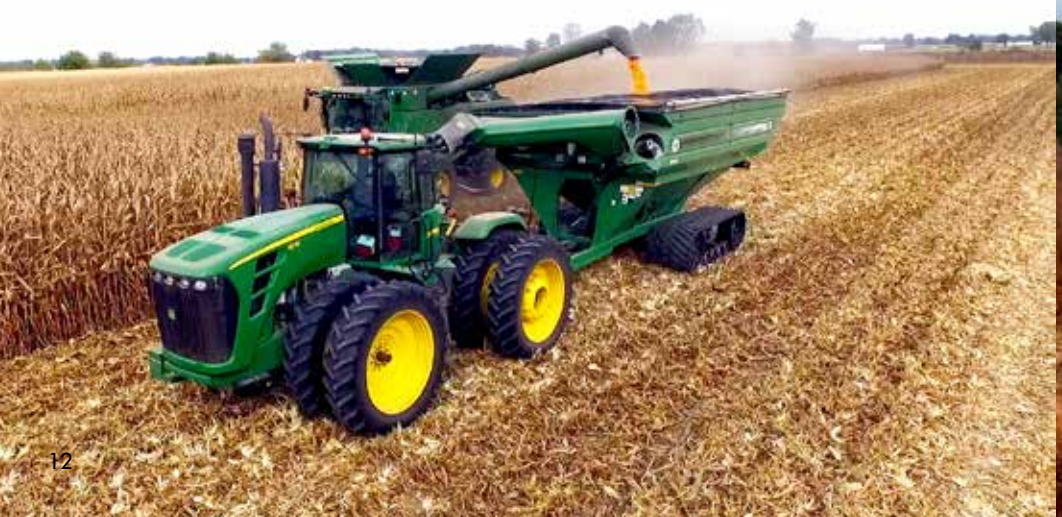
Tar Spot

- Relatively new disease in corn, first appearing in Illinois and Indiana in 2015 and then spreading into nearby states, especially Wisconsin and Michigan.
- Tar Spot in corn gets its name from the fungal fruiting bodies that look like spots of tar on corn leaves.
- Favored by cool temperatures (60-70°F), high relative humidity (>75%),frequent cloudy days and 7+ hours of dew at night.
- Tar Spot can readily spread through the corn canopy under favorable conditions, causing premature leaf senescence.
- Commercial hybrids vary in their susceptibility to Tar Spot. Hybrid selection should be the primary method in managing for Tar Spot.
- Fungicide treatments have varied in their ability to control Tar Spot. Specific recommendations are still being developed.

HARVEST

Proper harvesting techniques are important for creating initial grain quality. When looking at Grain Millers specifications for food-quality corn, many attributes are affected by harvest. When starting harvest, grain moisture should be around 20% if possible. Wet corn or corn that becomes too dry prior to harvest will break or crack easier during the threshing process.

Grain Millers purchasing specs allow for a maximum of 2% broken corn and foreign material (BCFM). BCFM is measured by shaking a sample over a 12/64th round sieve – anything that falls through is considered part of this content. Proper adjustment of the combine can help growers meet these requirements. Start with a wider concave setting and lower rotor speeds than recommended. Once harvest has started, begin to increase speeds and tighten the concave to find the ideal settings. By performing the process in this manner, you will reduce the amount of cracked and broken kernels which become FM in the final

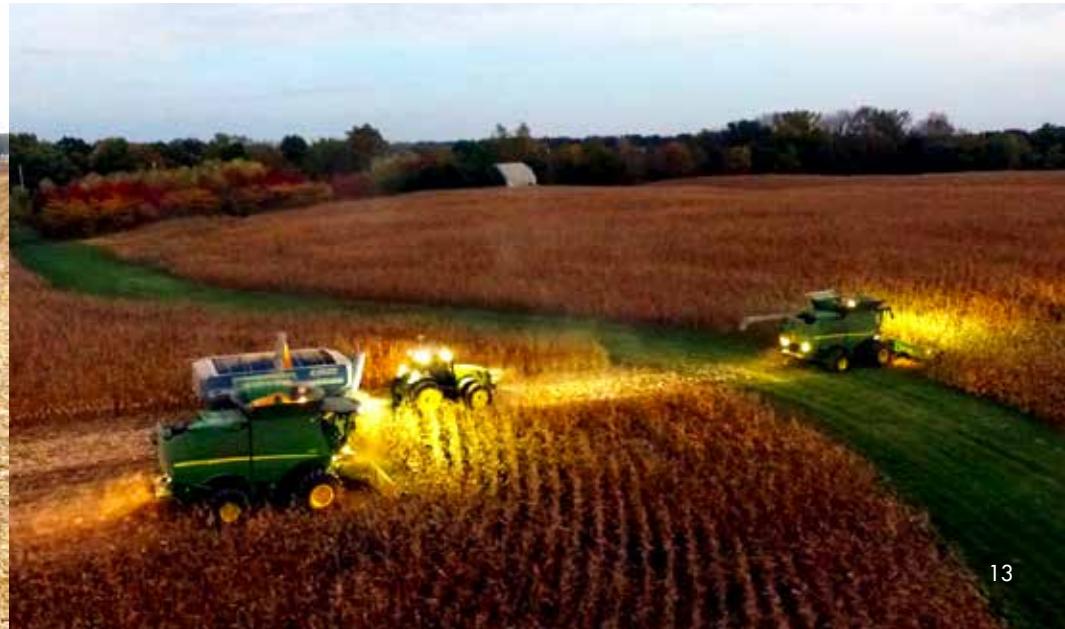


HARVEST (continued)

grain product. It can also be beneficial to increase fan speed to help reduce the amount of FM in the grain.

Reducing GMO presence in Non-GMO and organic corn is critical when striving to participate in the food market. Though you have carefully planned field locations, it can be difficult to completely control pollen drift. To help reduce the risk of GMO contamination, it can be beneficial to harvest border rows, keeping that corn separate from what is being sent to the food market until it can be tested for GMO presence.

When harvesting white corn, the border rows should also be used to help flush any yellow corn from the combine and other equipment. This is done to reduce the risk of yellow corn contamination in the grain. Flushing equipment is still important in yellow corn harvest but it is done to help reduce general foreign material.



DRYING, STORAGE & HANDLING

Listed on the following pages are the recommendations from Grain Millers for the safe and effective storage of corn on-farm, in order to preserve grade, prevent damage from molds and insects, and ensure food safety of the quality corn that's harvested.

1. All bins and handling equipment – regardless of size/capacity, frequency of use, and location – MUST be thoroughly cleaned, removing all previous grain residues, molds, and debris. This includes cleaning out of all bin augers and transfer equipment, as well as under perforated drying and/or aeration floors. Besides removal of all grain and foreign materials, we recommend the use of high pressure air. Molds, insects, grain dust, foreign material, broken grain, and water collect in these areas, and can quickly create a "cocktail" of molds and mycotoxins which can then be spread effectively into the stored grain mass. SAFETY FIRST – always disconnect all power sources to any mechanical devices and/or bins before cleaning.

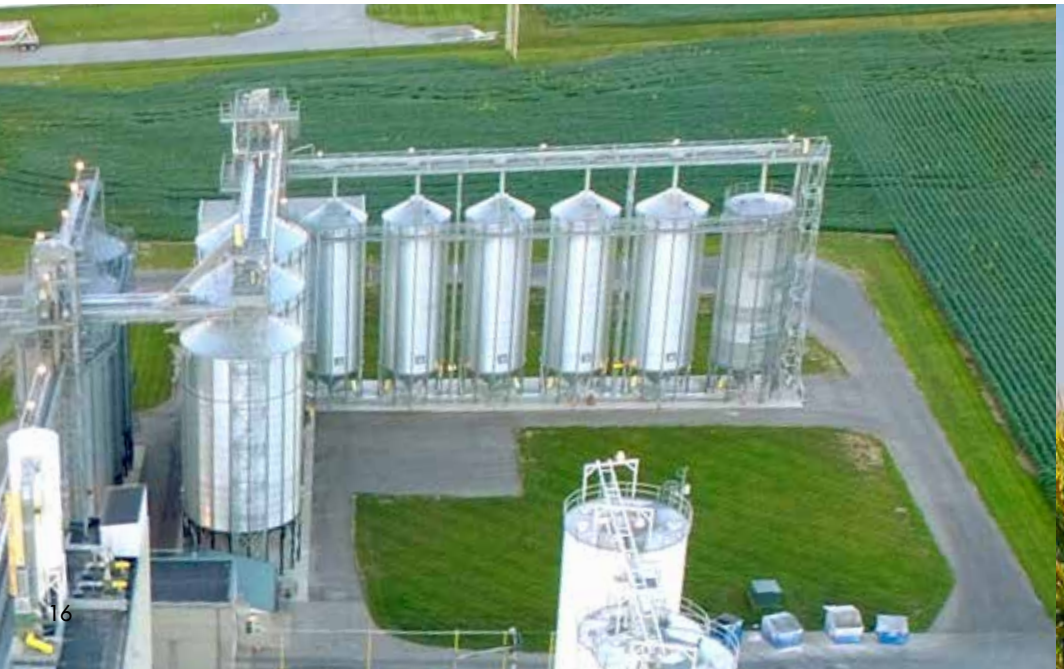
DRYING, STORAGE & HANDLING (continued)

2. All bins, regardless of size or structure, must be able to be completely sealed to prevent water getting to the grain (rain, snow, wind, etc.) and insect infestation. All bins should have tight hatches and covered vent openings, and all bin sites should provide a clean area around the bins with no weeds, piles of debris, and old grain spillage, in order to avoid insect and mold growth. Repair any hole, crack, or seam with a food safe, strong material prior to filling the bin.
3. All corn must be uniformly dried and cooled to ambient temperatures prior to long term (over 1 month) storage. Although some "equilibration" of moisture can occur in grain masses, you should NEVER blend wet corn (over 15%) with dry grain, and simply hope for moistures to "even out". Insects will seek out the damper grain pockets, and molds and mycotoxins will grow quickly in ambient air. Immediately after drying grain, attempt to cool it to within 10°F of outside air, but not below 32°F.
4. Do not discharge corn from the grain dryer at temperatures over 97°F (actual grain temperature) and use high volumes of air to prevent over-heating. Drying at higher temperatures will increase the amount of stress cracks. A high amount of stress cracks reduces the quality of the corn and limits the use in some food markets. After two hours of drying time, start taking samples of dried corn from the dryer and check for stress cracks and overall grain quality. If the level of stress cracks is below 10%, continue drying with current settings and recheck again every hour. If stress crack percentage increases, reconsider dryer settings and temperature.
5. We recommend moistures of clean corn grain to be less than 15% moisture when stored or delivered in the fall and winter, and

DRYING, STORAGE & HANDLING (continued)

not higher than 14.5% moisture if stored and delivered in the following spring. During summer and early fall, it is recommended that moisture be reduced to 14% to help reduce mycotoxin risk. Grain Millers requires 14.5% or less moisture at delivery.

6. If the harvested corn contains significant levels of foreign material, cracked, broken, or diseased kernels we highly recommend cleaning the grain with a mechanical grain cleaner/sieve and/or air volume prior to storage. Increased handling of corn will cause higher levels of broken kernels and other foreign material. Foreign material (fines, weed seeds, dirt, etc.) is normally higher in moisture than the actual grain kernels. The corn grain stores much better with air movement throughout the bin, and some relatively easy cleaning prior to long term binning facilitates air movement through the grain.



DRYING, STORAGE & HANDLING (continued)

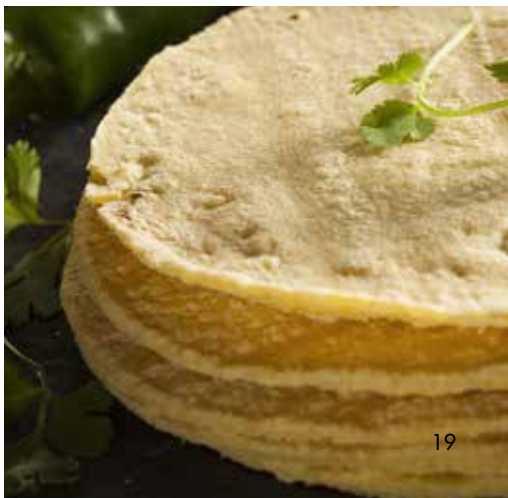
7. Provide for adequate ventilation of the grain via aeration fans. During the fall and early winter, cool the grain on a regular basis until the grain temperature nears 32°F. For extended storage periods, you should warm the grain in the spring, attempting to bring the grain up 5°F or less at a time to avoid moisture formation in the grain mass. It is critical that once a temperature change is initiated, it must be continued until complete. If this is not done, when the aeration is stopped, the warm, moist air will condense on the cool grain, and a crust will develop, usually within the top few feet of the grain mass. During summer months, aerate during cool, dry nights to hold grain temperatures down. Depending upon bin size, volume of grain stored in that bin, and bin manufacturers, a general rule of thumb for effective grain aeration is at least 1/4th CFM/bu.

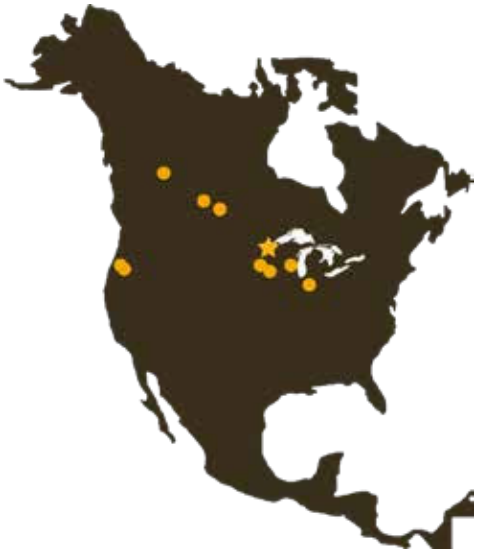
DRYING, STORAGE & HANDLING (continued)

8. Diatomaceous earth application is approved for organic, but farmers must notify Grain Millers of its use prior to delivery. Licensed grain fumigants can be used for non-organic certified corn stored for several months on-farm, but must not leave ANY traces of residues.
9. Develop a plan and schedule for safe grain moisture and temperature monitoring. During the fall and spring, we recommend checking the bins weekly to avoid rapid moisture and temperature variations. Remember, on warm spring days, the grain just inside the shiny metal bins on the sunny side of bin warms quickly, and far slower on the shaded side. The bin can then form its own "atmosphere," and grain spoilage can occur.
10. If aeration is not an option for a bin, many farmers have successfully "turned" (emptying and refilling) a bin while incorporating a rapid, effective cleaning operation to remove more fines, debris, and light material. Many farmers have reported small increases in test weights when performing this operation, and being able to store the grain longer. Effective, licensed fumigations can also be performed along with this practice.
11. For a more detailed resource on the drying, handling, and storage of food-grade corn, please obtain a copy of:

    Quality Grain Care
    A Grower's Quick Reference – 2019 printing
    By John T. Gnadke
    515.964.9885

NOTES





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