



THE NEW GROWERS' GUIDE TO PRODUCING ORGANIC FOOD-GRADE GRAINS IN THE UPPER MIDWEST

Many Midwest grain growers are familiar with producing commodity grains – indeed, corn and soybeans delivered to grain elevators make up the majority of crop acreage in the Midwest. For farmers that are interested in producing **food-grade grains**, higher value grain crops intended for direct human consumption as food, there are a unique set of opportunities, challenges, and considerations that must be met to grow and sell a crop successfully. This guide is intended for farmers interested in adding food-grade grains to their rotations, whether they are new to farming, or interested in incorporating these grains into an existing commodity grain, diversified vegetable, or livestock operation.

In the broadest sense, a 'food-grade grain' is any edible grain crop that meets minimum quality and safety standards for human consumption. Food-grade grains are meant to be eaten by people, either directly or as ingredients in foods or beverages. Food-grade grains may be directly marketed to an end-user or intermediary processor, or sold on commodity markets or through a number of other marketing channels. In this guide, the term 'food-grade grains' refers to any crops producing edible seeds handled in similar manner and scale – including cereals like rye and barley, legumes like dry beans or lentils, oilseeds such as sunflower or canola, and buckwheat or other pseudocereals. Common examples of food-grade grains include wheat sold by market class (such as hard red winter wheat), or a white corn produced for a manufacturer of tortilla chips.



Ripening wheat

'Culinary grains' are a subset of food-grade grains typically directly marketed to end-users including artisan mills, restaurants, or home cooks. In most cases, culinary grains adhere to the same baseline requirements of food-grade grains (safety and quality testing) but have additional specialty attributes. Variety selection is extremely important for culinary grains, and information about the cultivar name, as well as where and by whom the crop was grown, are often intentionally carried through to the end-user, a process called identity preservation. In many cases, the history of production or the historical and culinary background of the variety are what create market demand. This differs somewhat from general food-grade grains, where multiple varieties and grain lots may be aggregated by market class and specific variety name may be less important to buyers.

Though the culinary grain market is still developing and selling these crops requires significant work on the part of the farmer, culinary grains often command the highest prices, making them attractive for small and mid-size growers that require higher profitability per acre and are willing to undertake more time-intensive and complex marketing pathways. Culinary grains are becoming increasingly important to businesses focusing on local and regional food systems, as well as culturally relevant food.

Regardless of the scale at which you wish to operate, food-grade grains have special requirements:

1. **Safety Testing:** All grain must be tested for the presence of fungal toxins (mycotoxins). Grain may also be tested for presence of pesticide residues, genetically modified organisms (GMOs), or allergens (gluten), depending on the intended market. The FDA has guidelines for acceptable levels of the mycotoxins deoxynivalenol, also known as DON or vomitoxin (all grain), aflatoxin (corn), fumonisin (corn), and toxins from ergot fungus (small grains). Vomitoxins are produced by infections of *Fusarium* head blight, whereas aflatoxin and fumonisin are caused by various species of ear molds. Ergot is prevalent in rye but also occurs to a lesser extent in other small grains.
2. **Quality Testing:** These tests are dependent upon the needs of your desired end-user. Check with them to see which tests they'd like to have. Quality testing verifies to buyers that your grain will perform as expected in their mill, brewery, bakery or other processing facility. Inspection services by a third party will provide an official Certificate of Analysis (CoA) for the grain lot. A list of these inspection services can be found below in [Section 7](#).
3. **Identity Preservation:** There is a more rigorous chain of documentation that accompanies food-grade grain lots, especially if you are trying to market specific varieties. This process is similar to contract production of identity-preserved soybeans or non-GMO corn, which may be more familiar to growers of row crops in the Midwest. You must ensure you keep food grade-production lots, and associated documentation or CoAs, separate and traceable.

In this guide, we will walk through the process of food-grade grain production using three examples of common grain types in the Upper Midwest: cereal rye as a winter grain, spring wheat as a spring grain, and corn as a warm season grain. We will introduce these three main categories of grains ([Section 1](#)), provide an overview of crop timing and potential rotations for each ([Section 2](#)) and discuss a few varieties commonly used for culinary grain production ([Section 3](#)). Guidance will be provided on where to source seed ([Section 4](#)) and resources for management of the crop in-season ([Section 5](#)). Finally, we will cover post-harvest handling ([Section 6](#)) and share additional resources that may be useful for those new to growing food-grade or culinary grains.



Section 1: Overview of the Three Main Categories of Food-grade Grains

For those new to grains, it is important to understand some basic categorical terminology. ‘Winter grains’ are annual crops planted in the fall that survive through the winter, to be harvested in early summer. This contrasts with ‘spring grains’ which are planted early in the spring and harvested late summer. Spring grains typically will not survive cold winters. Warm season grains prefer warm soils and a long growing season. They are planted mid spring and harvested as late as the weather allows, often in late fall or early winter. In addition, growers will also want to consider perennial grains when planning their rotation, whether traditional forages like alfalfa or a culinary grain like Kernza®. While we do not spend time on perennials in this resource, you can learn more about these important crops through your local university or grower groups listed in [Appendix I](#) and [Section 7](#) below.

Introduction: Winter Grains

Winter grains have enough cold hardiness to survive sub-freezing temperatures experienced by areas north of the 40th parallel (North of OH, IN, IL, IA). These crops are seeded in autumn, germinate with late-season rains, and then enter a dormant period during the winter months of freezing temperatures and snow. In the spring, as temperatures warm and ice thaws, they resume growth. They typically have a head-start on competitor weeds and will be ready for harvest a month (or more) before spring seeded grain crops. In many areas winter grains ‘kick off’ the beginning of harvest operations for the year, usually in mid-July. From a technical standpoint, true winter grains require a cold-chilling period and seasonal increase in daylight hours (photoperiod) to properly flower and form a grain-filled seed head. The chilling period is called vernalization, from the Latin word ‘vernal’ for ‘spring’; winter grains must experience the awakening seasonal cues of the shift from winter to spring to biologically trigger flowering. In very mild climates, some grain crops without a vernalization requirement may be grown over the winter months (see spring grains below). Some grain varieties called ‘facultative’ types can be planted as either winter or spring-seeded crops; however, in areas with significant freezing temperatures, it is important to only plant cultivars that are true winter grains with known ability to survive the cold ([Section 4](#)). Winter grains vary in their tolerance to cold and using the right planting date for your target crop is critical to achieve good survival. In general, rye is the most cold tolerant and can be planted the latest, followed by winter wheat and winter barley. In this guide we use **cereal rye (*Secale cereale*)** as an example for winter grain production. Other winter grains grown for food use include: winter wheat (*Triticum aestivum*) and winter barley (*Hordeum vulgare*).



Harvesting 'Warthog' hard red winter wheat

Introduction: Spring Grains

Spring grains are planted very early in the growing season, once the ground has thawed. They thrive in cool temperatures and mature quickly, most flowering by midsummer and are ready for harvest in late July or August. In this guide we focus on spring wheat as an example because it is one of the most common food-grade grains produced in the region. 'Spring wheat' can encompass many different types of wheat including hard wheat (bread) and durum wheat (pasta). Within those groupings, spring wheat can be classified by color as either white or red. For purposes of this resource, we focus on the most common type of wheat used for making bread, **hard spring wheat (*Triticum aestivum*)**. Other types of spring-seeded, cool season grains are:

Barley (*Hordeum vulgare*)
Durum wheat (*Triticum durum*)
Oats (*Avena sativa*)
Triticale (*X Triticosecale*)

Spelt (*Triticum spelta*)
Emmer (*Triticum dicoccon*)
Einkorn (*Triticum monococcum*)

Introduction: Warm Season Grains

Warm season grains are those which require the entire growing season (typically May through October) to mature and be ready for harvest. They often require warmer soils than winter or spring grains and thrive during the long, hot days of summer. Optimizing planting date is very important for maximizing yields in warm season grains. This optimal date will differ by region and between production systems, so it is important to follow your local university Extension's guidelines.

Warm season crops are often harvested last on a farm, sometimes not until early winter. We use **open-pollinated (OP) corn (*Zea mays*)** as a model to describe production and handling of warm season grains in this resource. Others include:

Cereal grains

Sorghum (*Sorghum bicolor*)
Millets (various genera)
Rice (*Oryza* spp.)
Teff (*Eragrostis tef*)

Grain legumes

Soybeans (*Glycine max*)
Cowpeas (*Vigna unguiculata*)
Dry Beans (*Phaseolus vulgaris*)

Pseudocereals

Buckwheat (*Fagopyrum esculentum*)



Examining varieties of OP corn in a replicated field trial at MSU Upper Peninsula Research & Extension Station. Varieties include 'Choices F1', 'MN 13', and 'Bloody Butcher'.



Section 2: What Type of Food-grade Grain Fits My Farm?

Crop Management and Timing Considerations

Most producers pursue food-grade grains because of the higher potential price paid per bushel or pound for such grains, making them some of the most valuable “cash crops” on a farm. It is important to keep in mind that cash crop quality is dependent upon the field rotation it is being grown in – it is critical to avoid continually growing your highest value crop without a plan to rotate to other complementary crops. Because of the high quality standards required of food-grade and culinary grains, you must plan a rotation that will benefit the economic and ecological health of your farm as a whole and give your cash crop the best possible chance of meeting quality requirements. A table follows that illustrates some guidelines for crop planning in several classes of food-grade grains.

For many farmers new to producing food-grade grains, it may work best to focus attention on one type of grain that is most interesting or valuable to you and then add diversity to the rotation as you gain experience. Consider when you have the most ability to handle the demands of planting, early season weeding, and harvest – these are some of the most time sensitive operations for successfully producing a high-quality grain crop.

It is also essential before planting a crop that you make a plan for post-harvest handling ([Section 6](#)). At a minimum you will need storage bins and fans. Be sure to explore these needs before you plant.

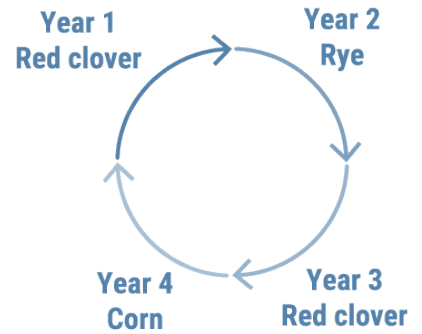
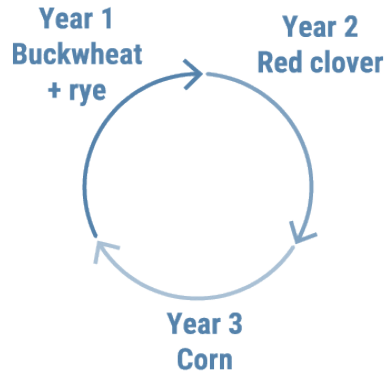
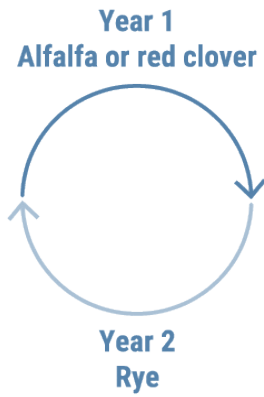
Section 2: What Type of Food-grade Grain Fits My Farm?

| Target cash crop | Grow at maximum | If you grow too frequently... |
|---|--|---|
| Winter small grain (wheat, rye, barley) | Once every three years (rotate out for at least two years) | <ul style="list-style-type: none"> • Soil-borne root and crown rot pathogens can accumulate • Fungal pathogens can build up and cause mycotoxin levels to exceed safe food- and feed-grade levels. The risk of <i>Fusarium</i> is greater after a corn crop, so you should not follow corn with a small grain • Continuous winter grains can lead to perennial or winter annual weeds • You must have a plan to manage volunteer plants which can sprout and survive the winter |
| Spring small grain (oats, wheat, barley) | Once every three years (rotate out for at least two years) | <ul style="list-style-type: none"> • Growing spring wheat after winter wheat can promote fungal diseases because they are the same species • Weed pressure in your field may increase because spring grains are less competitive with weeds • Continuous wheat can lead to contamination through 'volunteer plants' |
| Corn (hybrids and open-pollinated types) | Once every two years (rotate out for at least one year, but longer rotations are better) | <ul style="list-style-type: none"> • If grown too often, can build up <i>Fusarium</i> and other disease levels in grass crops in rotation • Heavy nitrogen feeder; grow after a lighter feeder such as a legume • Excessive applied nitrogen can cause lodging, especially in open-pollinated varieties |
| Legumes (field pea, dry bean, soybeans, etc.) | Once every two years (rotate out for at least one year) | <ul style="list-style-type: none"> • Root/crown molds and mite populations can build up in pulse crops in too-wet and too-dry years, respectively |

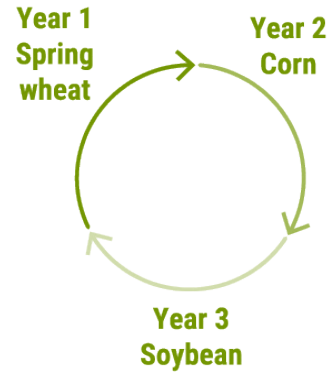
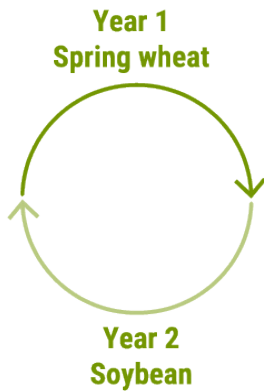
| Target cash crop | Planting window | Critical weeding | Harvest window |
|--------------------|-----------------|------------------|----------------|
| Winter small grain | Sept - Oct | Oct - Nov, Apr | July |
| Spring small grain | Apr - May | May | Aug |
| Corn | May | June | Sept - Nov |

Rotation Recommendations by Target Crop

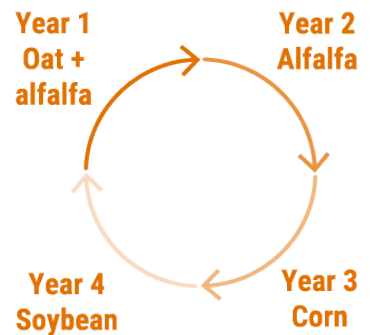
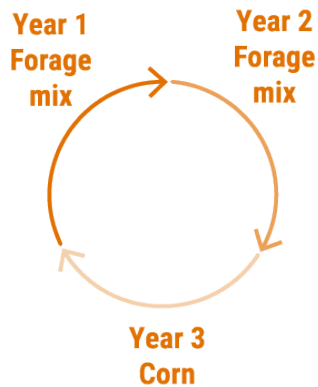
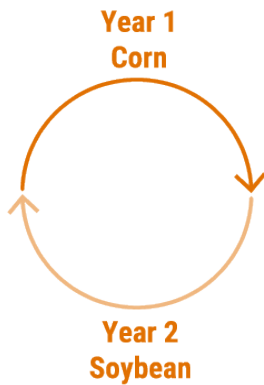
Target Cash Crop: Winter Small Grain



Target Cash Crop: Spring Small Grain



Target Cash Crop: Warm Season Grain



In this guide, we are focusing on rainfed production of grains, which accounts for the largest acreage in the Midwest. The information and timeline provided below is intended for beginning grain farmers planting a single crop into a clean-tilled field. As a farmer develops expertise, they may explore planting into standing cover, no- or reduced-tillage, and intercropping. Note that these management practices may significantly modify timing or ability to perform field operations as described below.

Reasons you may want to harvest small grains early, before they have dried down <15% moisture:

- ▶ *rain and low temperatures are coming (to avoid preharvest sprouting)*
- ▶ *you observe disease proliferation in your field*

It is highly inadvisable to use any vetches as cover crops in food-grade small grain rotations. Vetch seed is very difficult to clean out of rye or wheat seed lots and can even cause staining of grains, possibly resulting in rejection of grain lots by end-users. Vetch seeds are also unusually persistent in the soil and will cause problems year after year, especially for organic growers. Recommendations may vary by state due to differences in environmental conditions, and you can search for Extension guidelines for each crop in your state to find specific recommendations for fertility rates, planting dates, planting rates, and other management factors.

Winter Grains: Cereal Rye

Because a winter grain crop must be planted the fall prior to intended harvest, advanced planning of your rotational cropping sequence is required. You must be mindful of the crop preceding a rye crop to ensure sufficient time for planting before cold temperatures arrive, and make sure that the crop grown prior to rye will be harvested well before the target rye planting date.

▶ ***Tillage & Fertility (July - August, prior year)***

For all fall-planted small grains, tillage typically occurs in September or early October, just prior to planting. Some growers may work a field in midsummer if weeds require tillage control following harvest of the preceding grain or forage crop. Fertilizer or manure is typically broadcast prior to seedbed preparation, and then incorporated via seedbed prep tillage operations. Rate of fertilizer or manure application should be based on the nitrogen (N), phosphorus (P), and potassium (K) recommendations from local Extension services and your soil test levels of NPK. Often, Extension fertilizer rates are based on yield goals; you will have to find a way to estimate a yield you are targeting – this can be difficult if you don't have prior experience with that crop in the field you are working. It's advisable to pick a yield number on the lower end, so that you aren't spending money over-applying fertilizer while learning about your farm or a new crop. Rye is not a heavy feeder and excess nitrogen can make it more prone to lodging (falling over in the field prior to harvest).

▶ ***Planting (September - October, prior year)***

Rye planting must occur in the fall before the intended harvest as days are getting shorter, with enough time for the seed to germinate and establish but not so early that plants become overgrown or experience late summer heat stress. Plant rye using a grain drill at a rate of 60-100 lb of seed/acre at 1-2" depth, with a seed spacing of 3 inches. Most rye is planted with 6 or 7.5 inch row spacing, depending on equipment configurations.

Rye thrives under cool, moist growing conditions. In much of the Midwest, planting of winter grains occurs September to October, ideally between Labor Day and September 15th, with tillage and any nutrient applications completed shortly before planting. Rye is very forgiving in that it can be planted into November and still produce grain the following year, though earlier planting dates often result in larger and higher quality



Grain drill

crops. Some producers have even planted in December and experienced success. For the best quality food-grade rye crop, plant in late September/early October.

► **Early Season Weed Control (October - April)**



Tine weeding small grains

While it is not common to conduct cultivation operations in the fall, you can do so to control weeds at the 'white thread' stage. Ensuring adequate control of small weeds before the onset of winter allows the grain crop to outcompete any spring weed seedlings. Use of a tine weeder or rotary hoe usually occurs at time of planting and 2-3 weeks following. Many small grain growers will also frost seed clover into their winter grains to help with weed control. In the spring, your rye crop should be inspected for survival and for the presence of weeds. There is a window of time when a tine weeder can also be used for weed control in the early spring, though it is

important that such cultivation happen prior to 'jointing', or the point when stems elongate and joints become visible on the young plants. Once plants start the transition from vegetative to early flowering stages, visible as jointing, use of field implements can severely impact yield.

► **Midseason Operations (April - June)**

Rye and other winter grains have few management requirements during the period from thaw to harvest (April - June). If weed control was adequate, plants will usually fill in and shade competing weeds.

After flowering, scout your field to look for any indications of fungal diseases such as *Fusarium* or ergot. *Fusarium* infecting rye or other small grains can manifest at the crown and roots, or in the grain heads. *Fusarium* crown and root rot is evident by browning or dead tissue at the crown or brown/black tips at the end of shortened roots, if you pull up a plant. *Fusarium* head blight (FHB) symptoms include browning or white dying spikelets that are empty of seed. Ergot infects individual spikelets on a seedhead and the fungus will grow in the spikelet instead of the grain, evidenced by large black growths on the head. Knowing the extent of any pathogens in the field will help anticipate potential issues post-harvest, and allows you to assess your overall rotations and cultural practices for disease mitigation.

There are other diseases of winter grains, such as bunt and smut, though these are less common. Bunt is particularly concerning for food-grade production because it produces an off-scent and is not typically tested for in certified seed. If there are areas of your farm that have higher disease pressure, particularly for diseases that may affect your ability to sell food-grade grains (such as FHB), make note of them. You might want to harvest these areas separately and keep the grain in a separate bin until you have tested to ensure you do not contaminate your harvest.

► **Harvest (June - July)**

Rye is typically harvested towards the middle of the summer, often July in the Midwest, though actual harvest date will vary by region. Harvest timing is influenced heavily by the weather and planting date, but ultimately decided by the moisture content of the grain. Grain should be harvested when it reaches the target moisture for your end-use. For rye intended to be milled into flour, this is generally around 12%. Other end-users or buyers may desire the grain at a different moisture. Generally **once grain heads start to bend over** (no



Ripening 'Danko' rye

longer pointing straight up), they are “ripening” and nearing harvest moisture, so this is a good time to assess moisture. Generally, growers combine a few passes and then take the threshed grain from the combine’s bin to test moisture with hand-held moisture meters (see [Section 6](#)). These

meters come with calibrations for many crops (calibrations for oats, spelt, etc. are included for bin-run grain, meaning with the hull on); be sure to read the instrument manual and select the proper crop setting. If the grain is testing at too high of a moisture for harvest, growers generally stop combining and wait for warmer, dryer conditions. If testing near the target range, they proceed with harvest.

Spring (Cool Season) Grains: Spring Wheat

Small grains planted in the spring can provide a valuable crop that is harvested midseason, allowing subsequent planting of a winter grain or cover crop. Spring wheat is more challenging to grow than winter wheat, and lower yielding, but has a higher price point per bushel if a grower can produce a crop with adequate protein levels for baking. Because planting occurs very early in the season, growers must be ready to be flexible in response to inclement weather during planting such as cold temperatures, late thaw, or excessive spring rains and moisture. Spring wheat is more susceptible to weed pressure and weather challenges compared to winter grains, and should be planned for a field that is fairly 'clean' of weeds and does not have heavy, wet, or poorly draining soil.

► **Tillage & Fertility (September - March)**

Because of the very early planting dates associated with spring wheat, many operators perform primary tillage, nutrient applications, or weed control the previous fall, with only slight surface work or seedbed preparation prior to planting in-season. Fertilizer or manure application should be based on the nitrogen (N), phosphorus (P), and potassium (K) recommendations from local Extension services and your soil test levels of NPK. If you apply manure or compost for fertility, it is highly recommended that application be conducted the fall prior, as research has shown that adequate nutrient release to satisfy crop demands often only occurs if applied in the fall; spring application often results in inadequate fertility (most growers are using manure application rates between 1 and 3 ton/acre). For growers with small acreages or late planting dates (May), tillage and nutrient applications may be able to be accomplished shortly before planting, though it is not recommended.



A healthy wheat field just before flowering

► **Planting (April - May)**

The planting of a spring-seeded small grain crop such as spring wheat must occur as early as possible once frost is out of the ground and fields are dry enough to work without risk of compaction. Spring wheat is planted using a grain drill at a depth of approximately 1-2" depending on region and soil moisture, with a seed spacing of 3 to 5 inches. Recommended planting density can vary widely from 60-170 lb/acre, and all new growers should talk to Extension or successful wheat growers in their region for recommended seeding rates. Most wheat is planted with 6 or 7.5 inch row spacing, depending on equipment configurations. More specific information on calculating planting rate based on a target number of plants per acre can be found in the *Small Grains Field Guide* (**Section 7**). Organic growers should increase recommended seeding rates for conventional systems in their region because doing so can greatly aid in weed competition and control.

In much of the Midwest, spring wheat is planted in April through the end of May, with preference for earlier plantings. Early planting ensures the crop has as long as possible to grow in the cool, moist conditions of spring before transitioning to flowering during the drier summer months.

► **Early Season Weed Control (May)**

Tillage to control weeds is very important at early stages of crop growth, as there are few non-chemical options available once wheat plants reach a significant size. Ensuring adequate control of small weeds will allow the grain crop to outcompete any emerging weeds. Use of a tine weeder or rotary hoe usually occurs at the time of planting and two to three weeks following, up to the jointing stage. Recommendations for mechanical weeding of spring wheat are similar to those for winter grains provided above. Early planting can help the grain crop get ahead of weed growth, whereas later plantings typically result in more weed pressure within the crop – in fact, optimizing planting date for your region may be one of your most important weed management practices for spring grains. More weeds in the field can result in more contaminants in your grain lot at time of harvest and reduce the potential quality and value of a food-grade crop.

► **Midseason Operations (June - August)**



Fusarium head blight in small grains (wheat)

Small grains such as wheat require very little management during the period from midseason to harvest (June - August). If weed control was adequate early in the season, plants will usually fill in with tillers and shade any competing weeds. If weed control was not adequate, there will be very little that can be done without the use of chemical herbicides or more specialized weeding equipment.

After flowering, you should scout your field and look for any indications of fungal diseases such as *Fusarium* head blight, smut, or rusts. Use the *Compendium of Wheat Diseases* referenced in **Section 5** below to understand

what these diseases look like. Knowing the extent of any pathogens in your field will help you anticipate potential problems post-harvest. Fields that are showing increased presence of diseases midseason should be noted and considered for separate harvest, as grain from these areas will likely require more aggressive cleaning, moisture management, and rigorous testing to determine food-grade quality.

► **Harvest (August)**

Actual harvest date will vary by your region, but typically spring wheat and other spring-seeded small grains are harvested late summer, often in August in the Upper Midwest. Harvest timing is influenced heavily by the weather and planting date. Grain ripening and preharvest sprouting considerations are the same as those described for winter grains. However, once wheat is at physiological maturity (the stem is dry to about two inches below the head and no longer transporting nutrients to the head) it is potentially susceptible to preharvest sprouting if it rains and the heads stay wet. Preharvest sprouting can significantly reduce the quality of grain for various culinary

end-uses and is the primary phenomenon that causes low falling numbers in grain quality tests, which should be between 250 and 350 s for optimal baking quality. If there is a risk of preharvest sprouting, it is often better to harvest wheat before rain even if it means drying it afterwards.



Preharvest sprouting of wheat

Typically, spring grains fit well with warm season grains such as corn, because wheat harvest can be completed before harvest begins in the longer (warm) season crops. In general, other than timing, this process is similar to that of winter grains referenced above ([Section 2](#)).

Warm Season Grains: Open-pollinated (OP) Corn

The most common crops in the Midwest are spring planted, warm season grains – typically corn and soybeans. These crops are characterized by their tropical origins, affinity for heat, and rapid growth to produce very large quantities of grain. As such, they need the full late season to mature and reach their yield potential. They require warm soils to germinate, with lots of nutrients and moisture during establishment and flowering. With many of these crops, there is a balance needed between planting early enough to capture the full season vs. waiting to plant until soils adequately warm up. It is suggested that new growers start with a slightly later planting date to reduce the risk of low germination (poor stand) and a shorter-season variety to

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reduce the risk of late harvest (high moisture/inclement weather) until they become familiar with producing warm season grains. Open-pollinated corn is particularly good as a starting point for warm season culinary grains, because there are a wide variety of resources available across the Midwest for corn, and there is high demand for specialty types to produce foods like tortillas as well as alcoholic beverages.



'Wapsie Valley' heirloom corn in hand

► **Tillage & Fertility (September - March)**

While planting of warm season grains occurs later than spring grains, there is a similar pattern of performing primary tillage the year prior. Any manure or major fertilizer applications recommended by a soil test are performed prior to tillage and worked in. In the spring, secondary tillage and seedbed preparation is done prior to planting. Because corn has high nutrient requirements, growers will often 'split-apply' some supplemental nitrogen post-germination, using a broadcast spreader for manure. Furthermore, consideration of soil type is important for OP corn production because of the differential ability of soils to retain higher amounts of nutrients – the most robust grain harvests are typically produced on 'heavy' clay soils that can hold large quantities of nutrients without losing nitrogen to leaching. Soils high in organic matter will also have greater ability to hold larger amounts of nutrients and moisture. On sandy (or 'light') soils, nitrogen must be applied more frequently but in smaller doses to avoid polluting water via leaching. It is important to obtain a soil test and speak with your local agronomist or Extension agent about the cation exchange capacity (CEC) of soils in your field and its implications on frequency and timing of your manure and nutrient applications. Sandy soils can be improved via organic matter addition, and heavy clay soils can also become "tilthier" with organic matter additions over time. In essence, any soil will benefit from more organic matter!

► **Planting (May)**

Warm season grain crops require planting as early as possible. The limiting factors in achieving an early planting are soil temperatures and weather suitable for fieldwork. Corn is planted using a corn planter, which has more precise seed placement than a grain drill. Corn should be planted 1.5-2.5" deep depending on soil conditions, with deeper placement in drier soils. Be sure the seed is placed under the "moisture line" in soils, which you can find by digging or by looking at the furrow. Seed should always be planted into moisture and have good contact with the soil. Grain corn has a recommended minimum average soil temperature of 50° for planting, though for organic crops it may be advisable to wait until soils reach 55° to reduce the impact of cold temperature stress on young seedlings. Planting typically occurs from mid-April to late May; these crops have a very well defined planting 'cutoff' date after which they will not have enough time (or heat) left in the season to mature a crop. Because of the critical impact planting date has on the success of corn and other warm season grains, it is important that growers have all equipment, seed, and other necessary planning tools and considerations taken care of well before the earliest possible planting date. Additionally, having access to the seed of shorter-season cultivars (or an alternate crop) will mean that if planting is delayed due to wet or unseasonably cold weather, a grower will be able to shift to a faster maturing set of genetics and still obtain a crop. If you are new to producing warm season grains and prevented from planting during the optimal seeding window in your area, it is advisable to switch to an alternate crop and wait until the next season to produce a warm season grain.

Most warm season grains have well defined target planting density recommendations, produced on very specific row spacings. In much of the Midwest, corn and other warm season grains are grown using 30" or 36" row spacings. Corn is typically grown at a planting density of 25,000 to 36,000 plants/acre, with lower populations recommended for organic OP corn. Your local Extension office and seed dealer can give seeding rate recommendations based on your soil and the variety you are growing. Lower planting densities will require more aggressive weed control (less canopy shade),

but reduce plant stress and prevent quality or disease problems. Growers new to OP corn should start with a low planting density and then increase as you gain experience with a variety and field.

► **Early Season Weed Control (June)**

Weed control after planting corn is either chemical, through the use of pre-emergent and post-emergent herbicides until crops are too tall to drive over with a sprayer, or mechanical, using interrow cultivators or specialty devices such as flame weeders. Because chemical herbicide options are limited for organic growers, weed control will mostly need to be mechanical. Row spacing and planting density will impact a grower's options for mechanical weed control – your tillage and weed control equipment should match the row spacing on your corn planter. Be sure to plan on at least two passes with a tine weeder or rotary hoe before corn reaches the V5 stage (i.e., when corn has grown five leaves). After that, organic growers will need to use interrow cultivators to achieve primarily between-row weed control, and some in-row weed control. Some growers have two cultivator setups: the first cultivator aggressively tills the row and pulls soil away from the corn row; the second cultivator will till the middle of the row but will “throw” or “mound” soil back up onto the corn row, thereby smothering weeds. Talk with other growers to learn their methods when setting up your cultivator “fleet.” Most growers cultivate weekly or every two weeks throughout June. Cultivation must cease when corn is too tall and cultivating damages the corn.



4-row corn cultivator

Many warm season grains are not competitive with cool-season weeds early in the season and must be kept very 'clean' of small weeds until the crop is large enough to form a dense canopy that will shade and suppress weeds. June is often a surprisingly busy part of the year that requires frequent scouting and passes over the field for weed control. Because corn is a heavy feeder requiring large amounts of nitrogen, growers can sometimes combine operations and also apply a supplemental application of fertilizer during cultivation passes.

► **Midseason Operations (June - September)**



Japanese beetles feeding on silks of organic corn

Scouting for insect and fungal pathogens is the primary summer focus when producing warm season grains. In some instances, there may be organic-certified chemical controls for aboveground insect pests, though it is more difficult to control belowground insects or fungi. Common pests seen are corn borers, corn rootworm beetles, Japanese beetles, earworms, smut, and various stalk and ear rots. Use the *Compendium of Corn Diseases* (**Section 5**) to understand what these pests look like. Being aware of insect or fungal pathogen issues developing in your fields will help you to plan for any special handling requirements post-harvest. In fields with heavy insect or fungal disease pressure, early harvest and more aggressive cleaning settings on the combine or other post-harvest equipment will help reduce diseased grains and thus presence of mycotoxins

in the resulting crop. Stress from excessive summer heat or pests can also reduce the quality of a corn crop, lowering test weights or other traits buyers consider when purchasing grain.

► Harvest (September - November)

Actual harvest date will vary by region, starting as early as mid-September and extending into winter. In most years, the majority of harvest happens in October and the first weeks of November. In rare instances of excessive fall rains preventing harvest, warm season crops with strong stalks like corn may be left in the field into the winter and harvested once the ground freezes. For first-time corn growers, it is recommended to start with a shorter-season variety and plan to harvest as early as possible with some supplemental drying. While you may have a smaller overall yield, this will avoid problems associated with late-season harvest such as stalk lodging (plants falling over) or ear rots (mycotoxins).



OP corn harvest underway



Section 3: Which Varieties Should I Grow?

Choosing Seed for Food-grade Grains and Understanding Buyers' Requirements

One of the most important choices a farmer makes is selection of seed. It is critical to understand what cultivars or hybrids are adapted to your region – those that will be able to mature in your climate and possess the stress and disease tolerances relevant to your area. University Extension services (**Appendix I**) or state seed certification agencies (**Section 4**) are good sources of this information, in addition to recommendations from experienced nearby farmers. Because of the many resources available for specific variety recommendations, this resource focuses on how to understand seed selection based on quality requirements. It also provides an introduction to several of the most popular rye, spring wheat, and open-pollinated corn varieties currently in use as culinary grains.

When growing culinary grains, the key factor you need to consider in selecting a variety (beyond the variety's agronomic performance discussed in **Section 2**) is the quality specifications that will be required by your buyer, including whether you plan to market your grain as identity preserved. Buyer quality specifications are essential information, because not all varieties of a given crop will be able to meet those standards. Buyers will provide guidance on such requirements if they have them, often using a document called a 'spec sheet'. For example, a buyer of spring wheat may require a certain protein content in grain lots they purchase and only a limited number of wheat cultivars may be capable of achieving that protein level in your growing region. You would then take that information to your seed dealer to determine which varieties could obtain the desired protein level, as well as any other characteristics required on the spec sheet. In some cases, it may be difficult or impossible to meet the needs of certain buyers due to a lack of suitable genetics for your geography, or limited seed supplies.

Furthermore, you will need to know if your buyer (or you, if direct marketing) want to retain the identity of a variety all the way through the supply chain. A buyer's spec sheet may define a limited set of varieties, by name, that they will approve for purchase. For example, a buyer might provide a spec sheet stating they will only buy wheat over 12% protein and only from the cultivars 'Turkey Red' and 'Rouge de Bordeaux'. In such scenarios, it does not matter if a grower can produce wheat of the desired protein level if it is not one of those two specific varieties from the spec sheet. In many cases, the need to maintain the unique name of the grain being produced is related to the buyer's intended marketing of products, or name

recognition value to customers (this is common for heirloom grains, which some buyers exclusively demand). This is particularly true of the highest-value culinary grains, where buyers pay a premium for grain that allows them to tell the story of the variety being sold. In such instances, you will need to first determine whether the varieties your buyer requested can be grown in your region, and then secondly, if you are able to find a reliable seed source.

To avoid ambiguity and the risk of producing an unsaleable crop, growers are advised to develop a legally-binding grain marketing contract with a buyer, taking into consideration the details on the buyer's spec sheet, *before* purchasing seed or committing to plant a food-grade grain crop. When evaluating varieties and contracts, it is good to know the average expected yields of the varieties you are considering, to ensure that the price point you are selling for is reasonable. Spring small grains usually have higher protein and higher prices than winter small grains, but may yield only half as much. Similarly, traditional open-pollinated corn may command a higher price but have lower yields, so it is important to consider your expected return per acre rather than solely looking at yield or price.

Lastly, it is essential to understand the disease resistance inherent to the varieties you choose to plant. Breeding programs over the past several decades have made significant advances in developing resistance to *Fusarium* in wheat and other small grain varieties, and this may be very important in reducing mycotoxins in your food-grade grain crops. Open-pollinated corn is typically more susceptible to pathogens when grown at high planting densities, potentially resulting in greater incidence of stalk and ear rots compared to hybrid corn. Talk to your seed dealer or investigate variety trial results from your local university Extension program to gain an understanding of disease resistance levels in the different varieties you are considering. While traditional or 'heirloom' varieties may be in-demand for local markets, they are often susceptible to many diseases. Similarly, varieties developed outside of the region may succumb to diseases present in the Midwest that are not common where they were bred. This is particularly true for varieties developed in regions that have little to no summer rainfall that may be more prone to fungal diseases or preharvest sprouting due to precipitation or humidity in the Upper Midwest. Most seed companies should include a detailed description of each variety's end use and resistance characteristics on their websites; make sure that you examine these when choosing varieties. It is not advisable to plant susceptible varieties where known disease levels are present. **Do not buy forage, cover crop, or 'VNS' varieties** (see below) if you intend to market your grain crop for food-grade uses.

Grain contracts may consider the following:

- ▶ *What the grower is responsible for*
- ▶ *What the buyer is responsible for*
- ▶ *Number of bushels or acres that will be grown*
- ▶ *Delivery date and location for grain*
- ▶ *Transport and storage requirements*
- ▶ *When grain ownership is transferred*
- ▶ *Price and quality deductions*
- ▶ *Payment date and terms*
- ▶ *Compliance concerns*
- ▶ *'Acts of God' clause*
- ▶ *Any testing required by the buyer (see **Section 6**)*

Common Cultivars: Rye

In general, cereal rye is a lower value grain than either wheat or corn and sits somewhere between both of them in terms of quality testing requirements. The US has focused on developing rye primarily as a cover crop or animal feed, but there are also available varieties that produce grain well-suited for culinary uses such as milling and distillation. Because it is primarily used as a cover crop (not for food-grade grain production) many regional seed suppliers sell generic cereal rye as 'VNS' seed, which means 'Variety Not Stated'. VNS seed mixes are highly variable for grain characteristics but well-adapted to their area. Growers should not use VNS seed when attempting to produce a food-grade grain crop. Rye intended for food use should be a named variety, which are available from seedhouses specializing in food-grade and organic seed types. Because rye is typically used in applications with no premium placed on high protein levels (unlike wheat), food-grade testing requirements will often be related only to safety (ergot, *Fusarium*).



Rye head formation with slender florets and long awns

Many food products using rye focus on the sensory, flavor, or historical identity of rye varieties rather than compositional qualities. A premium is often placed on knowing what variety of rye is used. Because of this, growers interested in producing rye should talk directly with buyers and have a plan in place for identity preserved production, including a verified seed source of the variety requested and dedicated/separate grain handling and storage to prevent mixture with other grains or other rye varieties. In addition to many traditional varieties of rye, which are technically open-pollinated cultivars similar to traditional corn, there are also hybrid rye varieties that excel in yield. These rye hybrids often are reported to have more neutral and less variable flavor profiles that may be preferred by some buyers. Rye is free-threshing and does not require dehulling.

- ▶ **'Danko'** - heritage; traditional Polish variety with good milling and distilling characteristics. It has a strong, pronounced rye flavor.
- ▶ **'AC Hazlet'** - modern; Canadian rye variety with high test weight, competitive yields, and strong straw. A favored variety for distilling, balances strong agronomics with flavor and culinary applications. Recommended for first time growers.
- ▶ **'Rosen'** - heritage; historical distilling variety from Michigan, experiencing a resurgence in production in the Upper Midwest. Limited supply of seed and increasingly high market demand.
- ▶ **'Spooner'** - modern; variety developed by University of Wisconsin, tall and early heading. Has stronger, more complex rye flavor for milling, brewing, and distilling applications.
- ▶ **'Serafino' F1** - modern; hybrid variety. Very high yields with mild rye flavor.
- ▶ **'Bono' F1** - modern; hybrid variety. Very high yields; well adapted to drought conditions.

Common Cultivars: Hard Spring Wheat

Spring wheat has a well-established quality testing system and detailed expectations from buyers. Wheat is classified as spring or winter type, hard or soft, and red or white in color. Color classification relates to the color of the grain, and 'hardness' generally references the protein content. Because it is directly used in many common foods, wheat has the most rigorous testing needed for marketing. Often it requires certification on protein level and other compositional characteristics, as well as identity preserved production for the culinary grain market. There is a standard set of wheat quality assessments used to provide bakers or other processors with an overview of the protein content, extensibility (ability of dough to be stretched), and carbohydrate profile of the grain. As a very broad statement, wheat intended for bread is typically 'hard wheat' that needs a high protein level (>12%) and wheat intended for pastries or distilling is in the 'soft wheat' market class with low protein (<11%) levels. Spring wheat grown in the Midwest is typically hard wheat, while winter wheat can be hard or soft. Wheat is also one of the most susceptible crops to *Fusarium*, the fungus that produces vomitoxin (or DON). Because of this, the FDA has strict guidelines on acceptable toxin levels for wheat to be marketed as food-grade. A list of service providers that can perform both quality and safety testing that may be required by your buyer are listed in [Section 7](#) below.

Furthermore, in the culinary market, there is a high value placed on certain cultivars of wheat due to their historical or cultural significance. If you want to produce these, ensure that you can obtain seed of the variety being requested by your buyer and are aware of any specific challenges it may have in the field. The highest value traditional varieties of wheat are often taller and more disease susceptible than modern varieties, and can be challenging to produce. Your seed dealer will be able to provide details on any special management required by variety. Many small grains have awns, which are thin, spiky hairs that extend from the grain head. Wheat is variable and can have awns, be awnless, or have a few small awns at the tip of each flower and be called 'awnletted'. Spring wheat is free-threshing and does not require dehulling. Red wheat tends to have fewer pest and quality issues and is less susceptible to preharvest sprouting than white wheat.

- ▶ **'Red Fife'** - heritage; popular hard red spring wheat variety. Widely available and used by many artisan bakers. Recommended for first-time growers looking for a historic variety with a well-established market, but make sure you have a contract in place. Red, awnletted variety.
- ▶ **'Marquis'** - heritage; offspring of 'Red Fife', a heritage hard red spring variety with higher yields and slightly improved agronomics. Somewhat milder flavor than 'Red Fife'. Red, awnless variety.
- ▶ **'Glenn'** - modern; hard red spring variety released by North Dakota State University in 2005. Selected for a high level of resistance to *Fusarium*; high quality. Red, awned variety.
- ▶ **'Rouge de Bordeaux'** - heritage; French wheat of exceptional quality. It is facultative, meaning it can be planted as either winter or spring wheat, but is not always winter hardy in the Upper Midwest. Red, awnless variety.
- ▶ **'Linkert'** - modern; hard red spring variety released by University of Minnesota. High yielding with good disease resistance and high protein levels. Red, awned variety.
- ▶ **'Snowbird'** - modern; Canadian hard white spring variety, unique in having a high protein content and white grain. It is also used to make high-quality Asian noodles. White, awnletted variety.

Common Cultivars: Open-pollinated (OP) Corn

Corn is the most common Midwestern crop, but is generally produced as a commodity with minimal quality or safety testing. This is because most corn is used for livestock feed or industrial processing such as fuel ethanol. Food-grade corn has many uses, including raw milled products like cornmeal, beverages such as beer and whiskey, and nixtamalized foods including corn chips and tortillas. Production of food-grade corn requires safety testing for mycotoxins, particularly the carcinogenic aflatoxins produced by ear molds, as well as quality testing for protein, oil, starch type, and 'test weight'. Test weight is a grain characteristic that describes grain density, with higher test weight grain having a harder, more vitreous (glassy) endosperm. This density is an important distinguishing factor between food-grade corn and softer commodity dent corn types.

There are several well-established market classes of food-grade corn including white, 'food grade yellow', blue, and waxy corn. There are also markets for floury corn, high lysine corn, and high oil corn. All require safety testing and some level of quality evaluation, though typically not as extensive as in wheat. In culinary markets, production of specific varieties with known historical significance is economically important. Similar to wheat and rye, it is critical to speak with your seed dealer and ensure you can obtain needed seed for a variety being requested by a buyer before committing corn to your crop plan. There are dozens of traditional, open-pollinated (OP) cultivars and hundreds of hybrids currently available – the list below is only a small snapshot of those most suited to culinary grain production. Removing grain from the cob is called 'shelling' and while specialized equipment different from what is used in small grains production is required to shell corn mechanically, small (<½ acre) fields of corn can be harvested and shelled by hand if grain is left on the ear. Small-scale producers may also consider purchasing a table-mounted, hand-crank "sheller" for corn to separate grain from cob—these machines are very affordable (<\$1K). Motor-driven shellers are more expensive (<\$15K).

*A descendant of the wild grass teosinte, corn is native to the Americas, and central and essential to many cultures. Teosinte looks very different from what we think of as corn today, and resembles cereal grain heads more than modern ears. These differences illustrate the work of generations of Indigenous people, who domesticated corn from its wild beginnings into hundreds of traditional, open-pollinated forms, and adapted it to the wide-spanning latitudes of the American continents. Unlike uniform hybrid corn, open-pollinated corn is highly variable, susceptible to lodging, and often displays a wide variety of beautiful characteristics reflective of the biodiversity inherent in *Zea mays*.*

- ▶ **'Bloody Butcher'** - heritage/modern; OP, red dent corn from the mid-South. Widely grown and used to make grits, southern cornbread (white), and bourbon. Numerous regional variations with the same name. Mid to long-season, but ranging widely in adaptation, uniformity, and quality depending on seed source. Tall with high ears. Approximately 95 - 115 days maturity depending on seed source.
- ▶ **'Wapsie Valley'** - heritage/modern; OP mixed dent/flint corn that is predominately yellow with some orange and red ears. Makes a very nice cornmeal for northern cornbread (yellow). Percentage of different colored ears and grain composition varies depending on seed source. Very tall with mid-height ears. Approximately 85-105 days maturity depending on seed source.
- ▶ **'MN 13'** - heritage; OP yellow dent corn released by University of Minnesota in the late 1800s. First short-season yellow dent corn able to be grown in the Upper Midwest during the 20th century. Soft

Section 3: Which Varieties Should I Grow?

starch made it preferable for distillation and feeding to hogs. Medium height, approximately 80-100 days maturity depending on seed source.

- ▶ **'Dakota Black' Popcorn** - heritage; OP popcorn from the Central Plains. Black grain, variable for pointed or rounded kernels depending on seed source. Medium height and approximately 80-100 days maturity depending on seed source.
- ▶ **'Jerry Peterson Blue'** - modern; OP blue corn adapted to the North. Short stature with tillers, early maturing. Used for blue cornmeal, chips, brewing, and distillation. Stable high-performing strain for an open-pollinated blue, approximately 90-100 days maturity depending on seed source.
- ▶ **'Nothstine'** - heritage; OP yellow corn adapted to the north with occasional pale yellow or whitish ears. Tall with medium height ear placement, has very uniform smallish, cylindrical ears and distinct broad, flat grains. Variable for composition and depth of color depending on seed source, but generally harder with grain more similar to flint types than to dents. Excellent for yellow cornmeal, cornbread, and masa (tortillas). Approximately 90-110 days maturity depending on seed source.

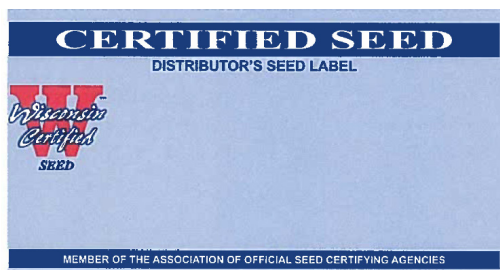


Section 4: Now That I Know What I Want to Grow, Where Can I Find Seed?

Seed Sourcing & Certified Seed

Farmers can purchase seed from commercial seedhouses or produce their own. For some high-value culinary grains, limited commercial sources may require growers to maintain their own seed – seed saving is very common for OP corn, for example. There is a range in quality and uniformity of seed for any given variety and the best results are often obtained from seed that has been professionally cleaned, inspected, and stored, as opposed to buying bin-run seed from a neighbor or other farmer. Seedhouses specialize in refining a seed crop to the highest purity and quality standards to ensure growers have the best probability of success.

Because of the impact that seed quality can have on the economic livelihood of a farm, commercially sold seed is regulated at the federal and state levels through various seed laws. Buying certified seed from a seed dealer registered with your state Crop Improvement Association (**Section 4**) guarantees it is true-to-type (matches variety description), free of weeds, and of a verified vigor (germination rate). A term often used interchangeably with certified seed is that of ‘blue tag’ or ‘blue label’ seed, referring to the color of the labels used to indicate seed classification in commercial trade. Certified seed costs more than non-certified seed, but ensures you will not be planting diseased, low viability, or weed-contaminated seed.



The seed in this container is from a seed lot which was produced, field inspected, and conditioned in accordance with the standards of the Seed Certifying Agency of the state(s) in which the seed was certified. IN CONNECTION WITH THIS SEED, THE CERTIFYING AGENCY MAKES NO WARRANTY OF ANY KIND, EXPRESSED OR IMPLIED, INCLUDING MERCHANTABILITY OR FITNESS FOR PURPOSE, OR OTHERWISE. The certifying agency only certifies that sample(s) taken from the lot of seed, believed to be representative of the seed in this container, met the standards of the certifying agency at the time the tests were conducted. The producer or vendor whose name appears on this container is solely responsible for the information which appears on the analysis label and for the proper use of this certification label.

WISCONSIN CROP IMPROVEMENT ASSOCIATION, INC.
8520 University Green, Middleton, WI 53562

Certified blue tag (front and back)

For organic growers, it is important to find seedhouses that sell ‘double certified’ seed – seed which is ‘blue tag’ and also certified organic. It is critical when talking with seed dealers to be clear on the need for ‘double certified’ seed if you are marketing your food-grade grains as organic – ensuring the seed is not only ‘certified’ for planting, but also ‘certified organic’. There is an exception for organic farmers that

allows planting of non-organic seed if there are no commercial sources of an organically produced seedlot. If you cannot find organic seed of your desired variety, it is important to check with your certification agency about this exception before purchasing non-organic seed. Growers must document their organic seed search, which involves keeping records of at least three seed dealers investigated who do not offer organic seed and the variety characteristics used to determine that no equivalent varieties are available organically. Check your certifying agency’s protocol while you are searching – documenting up front is easier than rectifying the issue later, during inspection. In some cases, particularly with rare traditional, heritage, or non-hybrid varieties, it may be easier for growers to maintain their own seed stocks than to try to obtain commercial seed.

Can't find organic certified seed of your target variety? Guidance from the USDA NOP is available here: [ams.usda.gov/rules-regulations/organic/handbook/5029](https://www.ams.usda.gov/rules-regulations/organic/handbook/5029).

Seed Certifying Agencies by State

Almost all states have a dedicated seed certification agency called a Crop Improvement Association. Crop Improvement Associations are a useful resource when trying to find seed of specific varieties, or looking for grain handling/cleaning services. State seed certification agencies are responsible for providing directories of facilities accredited to produce ‘certified seed’ and organic seed. Additionally, they maintain the foundation stocks of seed varieties released by public (university) breeding programs. Crop Improvement Associations can also provide listings of facilities approved for handling food-grade grain. In many cases, because the same equipment is required, these facilities clean both seed and food-grade grain, so you may be working with a seed cleaning company for processing your crop for human consumption.

Illinois

Illinois Crop Improvement Association
ilcrop.com
 888-455-3105
 3105 Research Road
 Champaign, IL 61822
 Seed Directory: ilcrop.com/seed-certification/

Minnesota

Minnesota Crop Improvement Association (MCIA)
[MNCIA.org](http://mncia.org)
 612-625-7766
 1900 Hendon Ave.
 Saint Paul, MN 55108
 Seed Directory: mncia.org/where-to-buy/

Indiana

Indiana Crop Improvement Association (ICIA)
[IndianaCrop.org](http://indianacrop.org)
 866-899-2518
 7700 Stockwell Road
 Lafayette, IN 47909
 Seed Directory: n/a

Missouri

Missouri Crop Improvement Association (MCIA)
[MoSeed.org](http://moseed.org)
 573-449-0586
 3211 Lemone, Industrial Boulevard
 Columbia, MO 65201
 Seed Directory: moseed.org/publications/

Iowa

Iowa Crop Improvement Association (ICIA)
IowaCrop.org
515-294-6921
59400 190th Street
Nevada, IA 50201
Seed Directory: **Iowacrop.org/Seed_Directory.htm**

Ohio

Ohio Seed Improvement Association (OSIA)
OhioSeed.org
614-889-1136
11491 Foundation Road, Box 3
Croton, OH 43013
Seed Directory: **ohioseed.org/publications/**

Michigan

Michigan Crop Improvement Association (MCIA)
MichCrop.com
517-332-3546
PO Box 21008
Lansing, MI 48909
Seed Directory: **michcrop.com/seed-products/seed-directory/**

Wisconsin

Wisconsin Crop Improvement Association (WCIA)
WCIA.wisc.edu
800-892-1341
8520 University Green
Middleton, WI 53562
Seed Directory: **wcia.wisc.edu/certfeedlist.html**



Harvesting 'Danko' rye



Section 5: What Do I Need to Produce a Successful Crop?

Agronomy Resources for Growers

Growing Winter Grains: Cereal Rye

There are many region-specific agronomy resources available providing information on winter grains production. The majority of these publications come from states that have significant winter wheat acreage or areas where winter grains such as rye are used primarily as a cover crop. The most extensive resources come from North Dakota State University, South Dakota State University, University of Minnesota, University of Nebraska, and Kansas State University. Rye-specific resources tend to be clustered in the Northeast with publications coming from Vermont, Maine, and New York. Some of the most useful resources for first-time rye producers include:

- ▶ University of Vermont, Cereal Rye Production Guide - uvm.edu/sites/default/files/Northwest-Crops-and-Soils-Program/Articles_and_Factsheets/Rye_Production_Guide.pdf
- ▶ University of Wisconsin, Rye - corn.agronomy.wisc.edu/Crops/Rye.aspx
- ▶ University of Maine, Winter Rye Variety Trial 2017 (good general info) - extension.umaine.edu/grains-oilseeds/topics/winter-rye-variety-trial-2017-results/
- ▶ North Dakota State University, Growing Rye as a Cover Crop (general rye agronomy) - ag.ndsu.edu/publications/crops/growing-rye-as-a-cover-crop-in-north-dakota

Some introductory videos available on YouTube:

- ▶ Ecological Rye Production - youtube.com/watch?v=Y8YfQdMqhYk
- ▶ Timing of Cereal Rye Planting - youtube.com/watch?v=f4QF181P-Cc
- ▶ Planting Small Plots of Winter Rye - youtube.com/watch?v=W1VMgbAFR-w
- ▶ Rye from Seed to Bread - youtube.com/watch?v=cQxUtpAltFM
- ▶ Where to Begin with Winter Wheat - youtube.com/watch?v=Q8rSCulCKZE

Growing Spring Grains: Hard Spring Wheat

When producing spring wheat or other cool season small grains, there are a variety of agronomic resources available from universities or commodity-specific trade groups. The majority of these publications come from states where there is a significant milling and baking industry presence. The most extensive resources for spring grains production come from the Dakotas, Minnesota, Illinois, Kansas, and New York. Some of the most useful resources for spring wheat and other small grains include:

- ▶ North Dakota State University, Wheat Production Guide - ndsu.edu/agriculture/ag-hub/ag-topics/crop-production/crops/wheat
- ▶ Kansas State, Wheat Production Handbook - bookstore.ksre.ksu.edu/pubs/c529.pdf
- ▶ Cornell University, Small Grains - cceoneida.com/agriculture/specific-crops/small-grains
- ▶ Iowa State University, Spring Wheat in Iowa - store.extension.iastate.edu/product/Spring-Wheat-in-Iowa
- ▶ University of Illinois, Small Grains Production Handbook - extension.cropsciences.illinois.edu/handbook/pdfs/chapter04.pdf
- ▶ Purdue University, Understanding Agriculture - Growing Wheat - extension.purdue.edu/news/county/whitley/2022/06/understanding-agriculture---growing-wheat.html
- ▶ University of Missouri, Wheat and Other Small Grains - extension.missouri.edu/programs/wheat-and-other-small-grains
- ▶ American Phytopathological Society, Compendium of Wheat Diseases - apsjournals.apsnet.org/doi/book/10.1094/9780890546604

Some introductory videos available on YouTube:

- ▶ Spring Wheat Production in ND - youtube.com/watch?v=h0AFgps0eXU
- ▶ How to Plant Wheat - youtube.com/watch?v=aJ85Lgsd89Y
- ▶ Growing Wheat for the First Time - youtube.com/watch?v=fk03EhG7v3c
- ▶ Backyard Wheat Harvest - youtube.com/watch?v=EW4Msbt1WGo
- ▶ UMN 2022 Small Grains Update - youtube.com/watch?v=O1vzFVj3Xu8

Growing Warm Season Grains: Open-pollinated (OP) Corn

Because warm season grains are the dominant crops produced in the US, there are extensive technical publications covering all aspects of production. While many of these resources are geared towards conventional production of corn, they contain a wealth of knowledge that can be adapted to organic operations. Though recommendations for many herbicides and fungicides will not be applicable to organic growers, some insect pest control strategies can be used with OMRI-approved chemistry such as Bt and pyrethrin products. Fertilizer application recommendations can also often be modified to organic liquid and pelletized fertilizers. The majority of these publications come from states in the heart of the corn belt, or to the more arid West for information on drought-tolerant grains such as sorghum. It is critical for new growers to learn as much as possible from these resources, but then to connect with successful organic corn producers to learn how to modify methods for success in organic systems. The most extensive resources for corn production come from Ohio, Indiana, Illinois, Iowa, Minnesota, Missouri, and South Dakota. Some of the most useful introductory resources include:

- ▶ Penn State University, Organic Corn Production - extension.psu.edu/organic-corn-production
- ▶ Rodale Institute, Organic No-Till Corn Production: Cover Crop and Starter Fertilizer Considerations- rodaleinstitute.org/science/articles/organic-no-till-corn-production-cover-crop-and-starter-fertilizer-considerations/
- ▶ Appropriate Technology Transfer for Rural Areas, Organic Field Corn Production - canr.msu.edu/foodsystems/uploads/files/Organic-field-corn-production.pdf
- ▶ Iowa State University, Guide to Iowa Corn Planting - store.extension.iastate.edu/product/Guide-to-Iowa-Corn-Planting
- ▶ University of Minnesota, Growing Corn - extension.umn.edu/corn/growing-corn
- ▶ Purdue University, Corn and Soybean Production Guide - mdc.itap.purdue.edu/item.asp?ItemNumber=ID-179
- ▶ North Dakota State University, Basics of Corn Production - ndsu.edu/agriculture/sites/default/files/2022-10/a834.pdf
- ▶ American Phytopathological Society, Compendium of Corn Diseases - my.apsnet.org/APSSore/Product-Detail.aspx?WebsiteKey=2661527A-8D44-496C-A730-8CFEB6239BE7&iProductCode=44921

Some introductory videos on YouTube:

- ▶ Organic Seedbed Prep for Corn - youtube.com/watch?v=anTVZnRDj70
- ▶ Corn Maturity Stages - youtube.com/watch?v=E0Gs8Cc0ltU
- ▶ Corn Nutrient Deficiencies - youtube.com/watch?v=OCN2CF2kPQU
- ▶ Corn Planting Depth - youtube.com/watch?v=ITMrnKuyJdQ
- ▶ How to Grow Blue Corn - youtube.com/watch?v=JOji_F0Ryvo
- ▶ Producing Popcorn in Indiana - youtube.com/watch?v=rk22qS-HQCU



Section 6: What Do I Need to Do After Harvest?

Post-harvest Handling of Food-grade Grains

Grain crops are staples of human civilization because intact grain can be stored for extended periods between harvests, often without specialized preservation practices. Once the seed is threshed, grains can be handled *en masse* for transport, cleaning, or processing. However, this beneficial aspect of grain crops also presents a challenge because the predominant attitude of grain-based commodity agriculture has been to scale, promote efficiency, and essentially anonymize grain by reducing it to broad market classes. Food-grade and culinary grain production is fundamentally different in that growers must think of their grain crop more like a horticultural product, handled with care and attention to maintain quality. To evaluate grain quality and value, you must test for various quality and food safety attributes beyond the minimum commodity standards to verify food-grade quality. This reality makes handling food-grade grains post-harvest of equal or greater importance than the consideration given to them throughout the growing season.

Grains don't leave the field completely free of hulls, broken grain, or other debris; there are a number of steps that may need to be taken between harvesting the crop and having grain ready to market. Possible post-harvest steps are listed below:*

1. Initial cleaning*
2. Drying*
3. Safety testing/certification*
4. Dehulling/debearding
5. Secondary cleaning*
6. Color sorting
7. Grading/sizing
8. Quality + safety testing/certification*
9. Storing*
10. Retesting/quality control

Do not let this list intimidate you! The most important steps are initial grain cleaning to prepare for short- and intermediate-term storage and safety testing. All other steps are dependent upon type of grain, harvest conditions, and/or intended buyer. While the post-harvest handling of each crop is unique, common major considerations discussed in this resource are **harvest, unloading, and first-pass cleaning, food-grade grain drying** (if needed), **on-farm storage, safety and quality testing of food-grade grains, secondary cleaning of food-grade grains to prepare for sale, and long-term storage of cleaned (finished) grains.**

* Post-harvest steps discussed in Section 6 below.

Harvest, Unloading, and First-Pass Cleaning

To set yourself up well for successful post-harvest handling of food-grade grains, it is important to thoughtfully calibrate combine settings. Initial cleaning happens in the combine, where the rotor, fan, and sieve settings are adjusted to thresh and blow out lightweight grain, chaff, and other contaminants. Harvesting grains with a higher fan speed (more forceful air) can sometimes reduce harvest through loss of some desirable grain, but it will also remove more contaminants, leading to higher quality. Growers should experiment with the settings on their particular harvest equipment while sampling resulting grain to find a



Rotary screen cleaner

balance between desired quality and acceptable harvest losses. If you are new to working with combines and plan to do your own combining, it is important to read your manufacturer's guide for adjusting settings and to work with an experienced farmer to practice correctly calibrating before harvest season. Do not wait until harvest or think you can work from the equipment manual alone – find a knowledgeable operator and have them walk you through how to make necessary adjustments and ensure you know your machinery well before harvest. Engaging

custom combining services (this can be as simple as asking a neighbor to bring their combine over) is another great option. Custom combiners are experienced in harvesting and a good one will be responsive to your needs and enable you to forego buying and maintaining your own combine, especially when just starting out.

Combines are most often unloaded into gravity wagons, which can then be driven to the storage yard. Before putting grain into storage (see **Section 6**), it is important to remove as much green or non-grain material as quickly as possible. Many growers do this using a rotary screen cleaner, which is essentially a rotating drum made of screen that grain passes through, separating out impurities. Removing green material will help keep moisture and temperatures low in storage, lowering drying time and costs, and also avoid the imparting of off-flavors and scents to food-grade grain. After green material is removed (i.e., "first pass" cleaning), grain can either (1) be dried if necessary, or (2) be placed into on-farm storage.

Food-grade Grain Drying

One of the fastest ways to ruin a good harvest is to store grain at too high of a moisture level. High moisture in storage leads to heating and fungal growth along with mycotoxin production. Almost all grains are considered storage stable and safe at 13% moisture. Small grains can be harvested in the 14-15% range (or lower) and the 14-18% range for corn. To monitor the moisture of your grain, there are numerous inexpensive and accurate hand-held grain testing devices that can be used. All grain growers should have one of these instruments to assess moisture prior to harvest and monitor during drying/storage operations. If you're in a pinch and can't get a moisture meter, you can take a grain sample (e.g., 0.5-1 lb), weigh it wet (record the weight), then put it in your oven at 200 deg F for ~8 hours, and then weigh it dry (record). You can calculate grain moisture using the calculation $\% \text{moisture} = (\text{Wet Wt} - \text{Dry Wt}) / \text{Wet Wt}$.

If required, adequate drying may be achieved by using fans circulating ambient air under low humidity conditions. When humidity is too high (relative humidity >60%), heat may also be needed, otherwise pulling high-humidity ambient air into grain can increase grain moisture. Grain that is excessively wet (e.g., 18% or higher) will also likely need heat to reach target moisture levels; ambient air alone will not dry it fast enough.

There are many types and sizes of drying devices ranging from simple portable electric heaters combined with fans attached to metal grain bins (with the heated air blown through a hole cut in the side of the container), to secondary gas-fired drying units that grain can be continually passed through (e.g., GSI grain dryer). If you are using forced-air heat to dry food-grade grain, **it is important to use low temperature settings**. Unlike most commodity grain, standard grain drying temperatures can 'cook' your food-grade crop and modify starches, enzymes, fats, proteins, and oils in the grain leading to off-type flavors or decreased quality. Because of this, it is recommended that growers closely monitor grain drying progress on food-grade lots, use low temperature heat or ambient air whenever possible, and stir grain thoroughly to avoid pockets of moisture or excessive heat (pay special attention to mixing along the walls of the container/bin). For food-grade corn, growers producing small amounts of grain can harvest intact ears and store them hanging in mesh bags with simple fans circulating air in the area. Growers should only send samples for quality testing once completely dried to a safe storage moisture, or that required by your buyer, and ready for storage. There are a wide variety of drier styles and configurations, and many growers get creative in constructing their own drying setup using the resources they have at their disposal.



Handheld grain moisture meter

On-farm Storage

Once dried to the target moisture, or after the first-pass cleaning if grain did not require drying, many growers put grain into storage, especially when direct-marketing and working with culinary end-users who do not have space in their facilities to store and maintain large quantities of grain.

Try your best to clean out wagons, augers, and containers as thoroughly as you can with brooms and vacuums before storing grain in them. Without cleaning, grains from previous lots can get mixed into your new grain. Cleaning and inspection also allow you to check for pest remains (nests, droppings, and carcasses) that you don't want in your grain.

A common necessity, especially for culinary grain production, is adjustment to working with smaller-size holding bins. Mid-size growers often set up three to six metal bins (e.g., 200 bushel volumes) with conical bottoms ("hopper bottoms") because they secure grain from pests, allow for air flow, and are easy to load, unload, and clean. Smaller metal bins can be found relatively inexpensively at farm auctions as remnants from a time when most US farmers produced grain at a smaller scale.

Gravity wagons are a common farmyard feature and can be made completely rodent-proof (rodents cannot climb their exterior walls). Dryers can be installed by drilling a hole in the side of gravity wagons, or it is common to use several screw-in portable aerators to dry grain lots in gravity wagons. Gravity wagons are a great affordable option for many. Lastly, for smaller lots or sheds, hopper-bottom bulk containers (i.e., Pro Boxes) are another rodent-proof option. These containers generally can hold ~2,000 lb of grain each, and have a pallet-like construction as the base, meaning they can be moved around in the same manner as pallets. Their hopper bottom has a trapdoor that pulls out after the container has been lifted (much like FIBC bags with a bottom spout), allowing for grain unloading (also will need equipment with a fork attachment for this operation). Bulk containers can be purchased new for \$600 to \$1,200, or less at auctions. **You will need either bulk containers, gravity wagons, or metal grain bins for long-term food-grade grain storage.** Farmers may choose to mix between these systems, using large bins as a form of primary storage, and then transfer to discrete bulk totes for filling individual orders, transport, or regional warehousing. Each operation will be different, owing to varieties grown, local environmental conditions, and requirements of buyers.



Portable aerator for bulk tote grain storage

Flexible Intermediate Bulk Containers (FIBC bags; also called bulk bags, grain totes, super sacks) are ideal for shipping and can be used as short-term storage, but they are easily infiltrated by rodents and other pests

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and should be used with caution as long-term storage. FIBC bags are soft, FDA-approved fabric bags that fit on standard pallets and can hold 2,000 lb of grain. For grain that needs to be sold or moved to buyers in small quantities, grain storage and warehousing using smaller, discrete volumes in these bags is helpful. Ideally, grain should be dried prior to placing in totes, but to dry grain in totes there are screw-in portable aerators that can be pushed into grain to circulate air. There are many different ordering options for FIBC bags online; it is recommended that you first order in small quantities or obtain samples to ensure you are purchasing the types of bags that work for your operation before ordering in large quantities.



Bulk-tote storage on farm



Pro box ("hopper bottom" container)

Safety & Quality Testing of Food-grade Grains

All food-grade grain must be tested for mycotoxins, chemicals that make people sick and can be produced by fungi that commonly grow on grain. The FDA has guidelines for the acceptable standards of the following mycotoxins: aflatoxin, deoxynivalenol (also known as DON or vomitoxin), and fumonisin. All grain must be tested for vomitoxin but only corn is required to be tested for fumonisin and aflatoxin. Allowable mycotoxin levels vary depending on intended use.

It is critical that grain be tested for safety before it is marketed to buyers. A list of certified laboratories that can perform this testing are included in **Section 7**. These labs will be able to issue an official Certificate of Analysis (CoA) for your crop that verifies safety to buyers. If your crop tests over allowable limits for certain mycotoxins, additional cleaning may be able to lower toxin levels below acceptable thresholds. For example, ergot contaminants are generally longer than small grains and may be able to be sorted out by length separation; color sorting can solve most contamination problems but this equipment is expensive and can be difficult to access.

Once testing for safety has been established, the second level of testing required is for various quality parameters. These are typically

Food-grade levels of DON in wheat must be <1ppm, whereas for swine feed the allowable level rises to up to 5 ppm (not to exceed 20% of feed), and for dairy cattle and chickens this is 10 ppm (not to exceed 50% of feed). Levels of aflatoxin must be <20 ppb and fumonisin must be <2-4 ppm in food-grade corn. Ergot thresholds vary by crop but are generally less than 1 ppm (1 g/kg).

measurements of grain's physical composition or small-scale tests simulating processes such as baking. Wheat is the most common grain that routinely undergoes quality testing to provide buyers (especially millers and bakers) with a CoA. While these tests can be very specific to particular baking applications, there are several 'baseline' tests that are commonly sought which include (1) protein level to indicate amount of gluten present, (2) falling number to indicate whether grain has been damaged due to sprouting (conversion of starches to sugars) and (3) farinograph to indicate the mixing qualities of dough. Note that these measurements typically come from samples of flour produced by milling the grain under assessment, not the whole grain directly. Falling number and farinograph are more specialized tests than protein level – only get them if your buyer requests it or if you know you want to use this information to help sell your grain. It is recommended to always test for protein content (reported as a percent). Other common grain quality measurements specific buyers may be interested in include lipid content and relative proportions of different types of starches in the grain. Similar to safety parameters, these tests can be performed by a certified laboratory ([Section 7](#)) and will carry a CoA. Many labs can perform both safety and quality testing.

It is important to remember that each food or beverage application will have a different desired quality profile, even within a particular crop. For example, a brewer making a local wheat beer may want grain with a lower percentage of protein to minimize frothing or cloudiness, whereas a baker making artisan bread would prefer grain with a higher percentage of protein in order to provide better structure to their loaves. Additionally, food-grade grains may be required to be tested for pesticide residues, genetically modified organisms (GMOs), or gluten depending on the intended market. The specific safety tests required for your crop will typically be outlined by your buyer or communicated through an official spec sheet (see [Section 3](#)). Talk to your buyer(s) and establish a clear understanding of the safety and quality testing they will require and then locate a lab able to provide the corresponding CoAs before planting. Talk with multiple buyers so you know what secondary markets or applications might be able to use your grain if you don't meet the specs of your initial intended buyer. Having a plan in place to quickly and accurately test grain post-harvest will prevent unwanted delays in moving grain off-farm and into the hands of buyers.

Secondary Cleaning to Prepare for Sale

Prior to shipment and sale, food-grade grain should be inspected to determine whether it requires further cleaning. Some farms opt to do their own secondary cleaning – the Clipper cleaner and the gravity table are commonly used implements for this purpose. The Clipper cleaner is the most common type of cleaning mill and can be found in a variety of sizes from tabletop models to large, room-sized industrial versions. Clippers pass grain through or over a series of screens that remove contaminants based on seed size and shape, and usually have a fan below the screens to blow off any remaining chaff or dust before grain travels through the output. Most farmers that do their own cleaning have a number of different screens on hand to fine-tune the sieving step. Gravity tables are more sophisticated and more expensive. They function by agitating grain over an inclined shaking screen surface with forced air passing through it – this



Gravity table seed cleaner

separates the grain not only by size and shape, but also by density. Because of this, gravity tables are able to achieve a very high purity of cleaned grain. Either of these options work well for small-scale producers and those wanting to handle the final cleaning of their grain on-farm.

For farmers producing food-grade or culinary grain in quantities greater than a few bulk totes (~6,000 lb), the cost of equipment that can finish larger volumes in a timely manner is more prohibitive, and it may make more economic sense to pay for cleaning as a service (toll cleaning). Options for toll cleaning include regional stand-alone cleaners geared specifically towards smaller lots of high-value grains, single farm entities who have invested in setting up a cleaning facility for their own crops and are willing to toll clean for other farmers, and commercial seed cleaning facilities. It is highly recommended that growers develop a good relationship with the closest reputable grain cleaner and understand their seasonal workflow and capacity to work with your crop. A good grain cleaner can be the critical factor to the success or failure of a food-grade or culinary grain operation.



Clipper mill seed cleaner

Other considerations when working with grain cleaning services include their organic certification status. Some buyers may require grain to be processed in a food-grade certified facility, or to have other third-party food safety certifications. Check with your buyers before contracting with a cleaner or processor, and be sure to use a facility with the appropriate certifications. Any cleaner certified to handle organic products will be able to provide proof of such certification.

Long-term Storage of Cleaned (Finished) Grains

Long-term storage of food-grade grains requires consistent environmental conditions and the ability to keep grain free of insects, molds, and pests. There is no 'right way' to do this, as each operation exists at a different scale and budget, and has varying existing resources at their disposal. Every specialty grain producer will have their own unique way of successfully storing grain, but all will have common shared goals of (1) controlling moisture to prevent molds and heating of grain in storage (2) controlling insect and animal pests (3) controlling excessive heat (or refrigerating) to prevent physical changes in grain composition and (4) controlling atmosphere to reduce oxidation.

Large operations can use traditional metal grain bins but may have difficulty controlling temperature (heat) or atmosphere (oxygen) without costly investments. However, such bins often work well for controlling moisture and pests and they are a good entry point for existing commodity producers wanting to explore food-grade grains. It is recommended that such growers start with wheat, rye, or corn which are not as sensitive to heat and oxidation as other high-oil grains like oats and beans. Be sure to have the correct size "false floor" on hand for the grain being stored – for example, corn and soybeans require a different false floor than do small grains. For small or mid-scale operations, use of discrete storage containers like

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gravity wagons or bulk containers/Pro Boxes allow for more targeted control of pests, temperature, and atmospheric conditions. If/when contamination occurs, there are affordable and safe fumigation methods that can be employed to kill insect pests. Grain can be placed in FIBC bags that can then be sealed in secondary large plastic bags and filled with CO₂ (via a canister or a bag of dry ice) or other inert gasses to asphyxiate any insects present. For certified organic production, be sure to check with your certifier before employing fumigation methods. Of course, grain will need to go through a cleaning/sieving step again to clean out the dead insects.

Whatever storage system is used, it is important to maintain records of the identity of each grain lot and tracking of any quality or safety testing paperwork (CoAs), whether for an individual tote or a several thousand bushel bin. Growers will also need to know how frequently stored grain must be tested to ensure that it is staying 'in condition', a term commonly used to describe grain that is within quality specs and still acceptable to buyers. If grain has been improperly handled or stored, it could potentially either become unsafe (moldy) or of unsuitable quality (rancid, sprouted). It is important to be in frequent communication with your buyer and understand what they consider a suitable storage period and conditions for grain, and if they require any periodic retesting before purchase in order to verify safety and quality.



On-farm food-grade grain storage



Section 7: Where Else Can I Learn about Food-grade Grains Production?

Additional Resources

In addition to the various Extension agencies, there are a number of non-university affiliated resources for those new to growing food-grade grains. These include facilities that can provide certified testing, government and trade articles on various relevant topics, as well as regional communities of grain growers and processors willing to share their knowledge. It is also helpful to read non-technical books, including cookbooks, on grains. While not exhaustive, this list offers a starting point for growers wanting to broaden their knowledge of food-grade grains.

Grain Testing Facilities

Mycotoxin/Safety Testing:

| State | Agency | Category |
|-------|---|---------------------------------------|
| AZ | Farwell Commodity Grain Services Inc | Private Agency |
| CA | California Agri Inspection Co Ltd | Private Agency |
| IA | Eurofins | Commercial |
| IA | Eastern IA Grain Inspection & Weighing Service Inc. | USDA - GIPSA - FGIS Service Providers |
| IA | Keokuk Grain Inspection Service | USDA - GIPSA - FGIS Service Providers |
| IA | Mid-Iowa Grain Inspection Inc. | USDA - GIPSA - FGIS Service Providers |
| IA | Omaha Grain Inspection Service Inc. | USDA - GIPSA - FGIS Service Providers |
| IA | D.R. Schaal Agency Inc. | USDA - GIPSA - FGIS Service Providers |
| IA | Sioux City Inspection and Weighing Service Company | USDA - GIPSA - FGIS Service Providers |
| ID | Idaho Grain Inspection Service Inc. | Private Agency |

Section 7: Where Else Can I Learn about Food-grade Grains Production?

| | | |
|----|---|---------------------------------------|
| IL | Cairo Grain Inspection Agency Inc. | Private Agency |
| IL | Champaign-Danville Grain Inspection Departments Inc. | Private Agency |
| IL | Kankakee Grain Inspection Inc | Private Agency |
| IN | Northeast Indiana Grain Inspection Inc. | Private Agency |
| IN | Ohio Valley Grain Inspection Inc | Private Agency |
| IN | Indiana Animal Disease Diagnostic Laboratory @ Purdue | University |
| IN | Indiana Crop Improvement Association | University |
| KS | Kansas Grain Inspection Service Inc. | Private Agency |
| KY | J.W. Barton Grain Inspection Service Inc. | Private Agency |
| KY | Breathitt Veterinary Center | Private Agency |
| KY | University of KY Veterinary Diagnostics Lab | University |
| KY | Waters Agricultural Laboratories Inc. | Private Agency |
| MI | Detroit Grain Inspection Service Inc. | Private Agency |
| MI | Michigan Grain Inspection Services Inc. | Private Agency |
| MI | USDA GIPSA FGIS | USDA - GIPSA - FGIS Service Providers |
| MN | Minnesota Valley Testing Labs | Commercial |
| MN | State Grain Inspection Inc. | Private Agency |
| MO | Romer Labs | Commercial |
| MO | Trilogy Analytical Laboratory | Commercial |
| ND | Grain Inspection Inc. | Private Agency |
| ND | Minot Grain Inspection Inc. | Private Agency |
| ND | North Dakota Grain Inspection Service Inc. | Private Agency |
| ND | Northern Plains Grain Inspection Service Inc | Private Agency |
| NE | Midwest Laboratories | Commercial |
| NE | Fremont Grain Inspection Department Inc | USDA - GIPSA - FGIS Service Providers |

Section 7: Where Else Can I Learn about Food-grade Grains Production?

| | | |
|----|---|---------------------------------------|
| NE | Lincoln Grain Inspection Service | USDA - GIPSA - FGIS Service Providers |
| NE | Hastings Grain Inspection Inc. | Private Agency |
| NY | Dairy One | Private Agency |
| OH | Tri-state Grain Inspection Service Inc. | Private Agency |
| OH | Holmes Laboratory Inc | Private Agency |
| OK | Enid Grain Inspection Company, Inc. | Private Agency |
| PA | Waypoint Analytical | Private Agency |
| SD | Aberdeen Grain Inspection Inc. | Private Agency |
| TN | Midsouth Grain Inspection Service | Private Agency |
| TN | barrow-agee laboratories | Private Agency |
| TX | Amarillo Grain Exchange Inc. | Private Agency |
| TX | Plainview Grain Inspection and Weighing Service Inc | Private Agency |
| TX | Quanta Lab | Private Agency |
| VT | University of Vermont E.E. Cummings Crop Testing Laboratory | University |
| WI | Dairyland Laboratories | Commercial |
| WI | Dairyland Laboratories | Private Agency |

Baking Quality/Compositional Testing:

| State | Agency | Website |
|-------|--|--|
| CA | California Wheat Commission Wheat Quality Laboratory | cawheat.org/milling/technical-and-laboratory-services/ |
| KS | International Grains Program (IGP) Institute | grains.k-state.edu/igp/wheat-flour-testing/ |
| ND | Northern Crops Institute (NCI) | northern-crops.com/technical-services |
| OR | Wheat Marketing Center | wmcinc.org/ |
| ND | Durum Wheat Quality and Pasta Processing Laboratory | ag.ndsu.edu/durumquality/ |
| ND | NDSU Hard Red Spring Wheat Quality Lab | ndsu.edu/faculty/simsek/ |
| IL | Illinois Integrated Bioprocessing Research Laboratory (IBRL) | ibril.aces.illinois.edu/ |
| IA | Eurofins Food & Feed Testing | eurofins.com/food-and-feed-testing/industries/grain-testing/ |
| VT | University of Vermont E.E. Cummings Crop Testing Laboratory | uvm.edu/extension/nwcrops/cereal-grain-testing-lab |

General Safety Testing Information

- ▶ Vermont Law School Center for Agriculture and Food Systems & Artisan Grain Collaborative, Understanding the Food Safety Modernization Act (FSMA) Preventative Controls Rule, A Guide for Grain Businesses - vermontlaw.edu/academics/centers-and-programs/center-for-agriculture-and-food-systems/guides/grain
- ▶ FDA, Overview of Mycotoxins in Food - fda.gov/food/natural-toxins-food/mycotoxins
- ▶ EPA, Setting Pesticide Safety Tolerances for Pesticide Residues in Food - epa.gov/pesticide-tolerances/setting-tolerances-pesticide-residues-foods
- ▶ University of Wisconsin, Methods for Detecting GMOs in grain crops - corn.agronomy.wisc.edu/WCM/W094.aspx
- ▶ Food Manufacturing, Manufacturing considerations for gluten-free products - foodmanufacturing.com/ingredients/article/13164276/manufacturing-considerations-for-glutenfree-products
- ▶ FDA, Advisory Levels for Deoxynivalenol (DON) in Finished Wheat Products for Human Consumption and Grains and Grain By-Products used for Animal Feed - fda.gov/regulatory-information/search-fda-guidance-documents/guidance-industry-and-fda-advisory-levels-deoxynivalenol-don-finished-wheat-products-human
- ▶ FDA, Fumonisin Levels in Human Foods and Animal Feeds - fda.gov/regulatory-information/search-fda-guidance-documents/guidance-industry-fumonisin-levels-human-foods-and-animal-feeds

Non-technical Food-Grade Grains Books & Cookbooks

- ▶ *Oceans of Grain: How American Wheat Remade the World* by Scott Reynolds Nelson, Basic Books (2022)
- ▶ *Southern Ground* by Jennifer Lapidus, Ten Speed Press (2021)
- ▶ *The Organic Grain Grower: Small-Scale, Holistic Grain Production for the Home and Market Producer* by Jack Lazor, Chelsea Green Publishing; second edition (2013)
- ▶ *Beautiful Corn: America's Original Grain from Seed to Plate* by Anthony Boutard, New Society Publishers (2012)
- ▶ *The New Bread Basket: How the New Crop of Grain Growers, Plant Breeders, Millers, Maltsters, Bakers, Brewers, and Local Food Activists are Redefining Our Daily Loaf* by Amy Halloran, Chelsea Green Publishing (2015)
- ▶ *Grains for Every Season: Rethinking Our Way with Grains* by Joshua Fadden and Martha Holmberg, Artisan (2021)
- ▶ *Grist: A Practical Guide to Cooking Grains, Beans, Seeds, and Legumes* by Abra Berens with Lucy Engleman and EE Berger, Chronicle Books (2021)
- ▶ *Mother Grains: Recipes for the Grain Revolution* by Roxana Jullapat, W.W. Norton & Company (2021)
- ▶ *Gluten-Free Flavor Flours: A New Way to Bake with Non-Wheat Flours, Including Rice, Nut, Coconut, Teff, Buckwheat, and Sorghum Flours* by Alice Medrich with Maya Klein, Artisan (2017)

Other Food-grade and Culinary Grain Resources for the Upper Midwest

- ▶ University of Wisconsin, Organic Grain Resource And Information Network (OGRAIN) - ograin.cals.wisc.edu/
- ▶ Artisan Grain Collaborative - graincollaborative.com
- ▶ University of Minnesota, The Small Grains Field Guide by Wiersma and Ransom (downloadable PDF) - conservancy.umn.edu/handle/11299/51480
- ▶ University of Minnesota, Growing Small Grains - extension.umn.edu/small-grains/growing-small-grains
- ▶ Tufts Food Lab, The Grain Guide - store.extension.iastate.edu/product/Spring-Wheat-in-Iowa
- ▶ Practical Farmers of Iowa, Small Grains - practicalfarmers.org/programs/field-crops/small-grains/
- ▶ Penn State University, Getting Started with Organic Grain Markets - extension.psu.edu/getting-started-with-organic-grain-markets
- ▶ Purdue University, Food Grade Organic Grain Processing and On-Farm Storage (video) - youtube.com/watch?v=eMK5CrwN0ks

Appendix I: Land Grant University Extension Services by Region & State

Growers can find information about production, processing, storage, and more through the Extension service programs listed below. Though many are outside of the Upper Midwest, the resources they provide may be relevant to Midwest farmers.

Northeast

- ▶ Maine - University of Maine - extension.umaine.edu/
- ▶ New Hampshire - University of New Hampshire - extension.unh.edu/
- ▶ New York - Cornell University - cals.cornell.edu/cornell-cooperative-extension
- ▶ Pennsylvania - Penn State University - extension.psu.edu/
- ▶ Vermont - University of Vermont - uvm.edu/extension

Midwest

- ▶ Illinois - University of Illinois Urbana-Champaign - extension.illinois.edu/
- ▶ Indiana - Purdue University - extension.purdue.edu/
- ▶ Iowa - Iowa State University - extension.iastate.edu/
- ▶ Michigan - Michigan State University - canr.msu.edu/outreach/
- ▶ Minnesota - University of Minnesota - extension.umn.edu/
- ▶ Missouri - University of Missouri - extension.missouri.edu/
- ▶ Ohio - The Ohio State University - extension.osu.edu/
- ▶ Wisconsin - University of Wisconsin-Madison - extension.wisc.edu/

Plains

- ▶ Kansas - Kansas State University - ksre.k-state.edu/
- ▶ Nebraska - University of Nebraska-Lincoln - extension.unl.edu/
- ▶ North Dakota - North Dakota State University - ndsu.edu/agriculture/extension
- ▶ Oklahoma - Oklahoma State University - extension.okstate.edu/
- ▶ South Dakota - South Dakota State University - sdstate.edu/sdsu-extension

Photo Sources

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- ▶ Page 4: *Harvesting 'Warthog' hard red winter wheat*, John Wepking, Meadowlark Organics
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- ▶ Page 10: *Grain drill*, Gulf Coast Media, gulfcoastmedia.com/the-islander/stories/county-residents-can-rent-grain-drill-to-help-with-seed-planting,106325
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- ▶ Page 11, *Ripending 'Danko' rye*, Dr. Nicole Tautges, Michael Fields Agricultural Institute
- ▶ Page 12, *A healthy wheat field just before flowering*, Dr. Nicole Tautges, Michael Fields Agricultural Institute
- ▶ Page 13, *Fusarium head blight in small grains (wheat)*, University of WI, *BadgerCropWatch*, Damon Smith, badgercropdoc.com/fusarium-head-blight-scab-of-wheat/
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- ▶ Page 15, *'Wapsie Valley' heirloom corn in hand*, Wesley Rieth, Granor Farm
- ▶ Page 17, *4-row corn cultivator*, Big Iron Auctions, bigiron.com/Lots/JohnDeere3-Pt4RowCropCultivator
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- ▶ Page 22, *Rye head formation with slender florets and long awns*, Dr. Nicole Tautges, Michael Fields Agricultural Institute
- ▶ Page 26, *Certified blue tag (front and back)*, Wisconsin Crop Improvement Association, wcia.wisc.edu/seedcert.html
- ▶ Page 28, *Harvesting 'Danko' rye*, Dr. Nicole Tautges, Michael Fields Agricultural Institute
- ▶ Page 33, *Rotary screen cleaner*, WGI Ag-Equipment Sales, wgisales.com/product/farm-king-grain-cleaner/
- ▶ Page 34, *Handheld grain moisture meter*, DICKEY-john, dickey-john.com/products/moisture-testers/portable-moisture-testers/mini-gac/
- ▶ Page 35, *Portable aerator for bulk tote grain storage*, Dultmeier Sales, dultmeier.com/products/0.1642.2519/15662
- ▶ Page 36, *Bulk-tote storage on farm*, Dr. Nicole Tautges, Michael Fields Agricultural Institute
- ▶ Page 36, *Pro box ("hopper bottom" container)*, Bulk Container Express, bulkcontainerexpress.com/product/DuraGreen-45-x-48-x-50-Hopper-Bottom-Collapsible-Bulk-Container
- ▶ Page 37, *Gravity table seed cleaner*, JK Machinery, jk-machinery.com/machines/jgt-gravity-tables/
- ▶ Page 38, *Clipper mill seed cleaner*, Commodity Traders International, commoditytraders.biz/used-equip/clipper-27-seed-cleaner/
- ▶ Page 39, *On-farm food-grade grain storage*, Alyssa Hartman, Artisan Grain Collaborative (taken at Granor Farm)



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