INTRODUCTION

Once the grain is in the bin, it’s all over - time to kick back and relax, right? Well, not really. That’s industrial commodity thinking. Organic grain is purchased and used as food, feed, or seed. Each of these has quality expectations.

First and foremost, organic grain is food, and just like the products coming out of the garden, grain requires some management to preserve its integrity. The market demands top quality for top prices.

Even if you think that your grain is more likely to be marketed as animal feed, there is still every reason to preserve quality. Livestock, like people, do best on quality feed. Avoiding any sort of spoilage will preserve markets and maintain prices.

The third main use of grain is as seed. Here too, quality is essential. Seed quality, including germinability, vigour, and purity, is greatly impacted by storage and handling.

STORAGE TARGETS: CLEAN, COOL, DRY

Grain stores best when cool and dry. Under these conditions, the grain itself is largely inactive: germination is minimized, as is enzymatic activity within the seed that can lead to heating and spoilage. Cool, dry grain is less likely to emit odours that attract storage insects. When cool, insects are less active. When dry, moulds and insects are less able to grow, develop and spread.

Ideals of temperature and moisture apply to the entire contents of the bin. Extraneous items in the bin such as green grain, weed seeds, chaff and field materials can increase the moisture in the bin. They can result in moulds, and in composting, which heats and deteriorates the grain. They can even lead to fires and explosions. These extra materials can also interfere with grain flow when augering, and with airflow when cooling, heating, or drying. Cleaning grain, removing non-grain materials, improves the storage potential of grains.

PREPARE FOR STORAGE AT HARVEST

If the crop is not uniformly dry, or if the field has green weeds, swathing can improve quality. Swathing also reduces losses from insects, shattering, hail, or frost. In general, swathing should be done when there are no more green kernels, and when the grain has reached a moisture level specific to that crop (Table 1). Crops weather better standing than in the swath, but also better in the bin than in the field.

Either straight-cut, or combine, when the crop is at the desired moisture level. It is important to avoid weathering issues such as sprouting, bleaching, staining, mildew and mould, or frosting.

Combining separates grain from chaff and weeds, using sieves and airflow that separate them, primarily by size, and somewhat by shape. Using the proper settings for the condition of the crop will avoid or at least limit damage to the grain. Manuals suggest cylinder speeds and concave settings for specific crops. Sieve spacing is critical. Proper settings will yield the most grain, of the best quality.

In general, running augers full and slow, keeping cylinder and ground speed low, and for some crops, closing the spacing between concaves and cylinders makes the harvest more gentle on seeds and reduces damage. Check and adjust settings as needed, but especially at the beginning of harvest, and as grain conditions change in the field. Watch for signs of damage in the grain, and for crop losses out the back of the combine.

“When you truly understand your crop’s role as a food ingredient, ... you begin to fully appreciate ... the steps necessary to make quality”

- Bruce Roskens, Grain Millers
Table 1. Maximum moisture content levels for harvest and storage*

<table>
<thead>
<tr>
<th>GRAIN</th>
<th>SWATH</th>
<th>COMBINE</th>
<th>LONG-TERM STORAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>OAT</td>
<td>25%</td>
<td>14%</td>
<td>13.5%</td>
</tr>
<tr>
<td>WHEAT</td>
<td>25-50%</td>
<td>14-20%</td>
<td>14.5%</td>
</tr>
<tr>
<td>KAMUT</td>
<td>18%</td>
<td>12.5-13.5%</td>
<td>14.5-13.5%</td>
</tr>
<tr>
<td>BARLEY</td>
<td>&lt;35% seed</td>
<td>14.5% feed</td>
<td>14.5-13.5%</td>
</tr>
<tr>
<td>RYE</td>
<td>40-45%</td>
<td>20%</td>
<td>14%</td>
</tr>
<tr>
<td>TRITICALE</td>
<td>May sprout in swath</td>
<td>14%</td>
<td>14%</td>
</tr>
<tr>
<td>FLAX</td>
<td>75% of bolls are brown</td>
<td>Seeds rattle in boll</td>
<td>10%</td>
</tr>
<tr>
<td>MUSTARD</td>
<td>25%</td>
<td>~9%</td>
<td>9%</td>
</tr>
<tr>
<td>LENTIL</td>
<td>Bottom 1/3 of pods yellow</td>
<td>18%</td>
<td>14%</td>
</tr>
<tr>
<td>PEA</td>
<td>25%</td>
<td>16-18%</td>
<td>16%</td>
</tr>
</tbody>
</table>

*Canadian Grain Commission and various commodity councils

SEED CLEANING

Often grain needs to be cleaned for sale or before its use as seed. Seed cleaning before long-term storage can greatly improve grain management and reduce risks associated with spoilage or reduced quality. However, cleaning should be done carefully, to avoid any splitting or cracking of the grain.

The first cleaning is usually with sieves and air. Some of this can be done at the combine, allowing non-grain material to blow out the back. However, the producer may choose to capture as much as possible in the combine, and clean with a separate cleaner before binning. Screenings can provide a valuable market stream, as they are in demand for animal feed.

Sieve sorting can include a variety of screens, rotating drums, disc separators, and graders which separate grain from items of different size. Small units such as the Kwik Klean can be a valuable investment, allowing a quick harvest time cleaning without the extra time and expense of taking material to a seed cleaner.

After sieving, a second stage of cleaning may be required. Due to the price of equipment and time necessary, this is usually done by a specialized facility. Gravity tables sort by density. This removes thistle heads, for instance, out of peas. A final stage may be a colour sorter, which can remove off colours, such as pea splits in oats.

BINS

Although it may be possible to sell grain directly from the field, most producers will see an advantage to storing grain, and thus increasing their marketing options. Under cool, dry conditions and proper drying and cleaning, storage for up to 6 months should not reduce quality. Grain does not improve in the storage, and longer-term storage requires careful management and increases the risk that quality will decline. Organic markets can fluctuate, making storage a wise choice under some circumstances, but long term storage is probably only a good idea for the better, cleaner, drier grain where quality loss is least likely.

Bin placement is important. Low spots in a field accumulate water, and attract insects, birds and rodents so they should be avoided. Ground around bins should be level, and if a water prone area can not be avoided, possibly gravelled. Pea gravel is the least rodent-friendly. Grounds around the bin yard should be clean from trash, old, or spilled grain or weeds. Good sanitation around bins can reduce the likelihood that insects and rodents will be attracted into the bin. This is especially important for bins that are flat-bottomed. Hopper-bottomed bins offer more challenge.

SAFETY FIRST!

ALWAYS BE CAREFUL AROUND AUGERS, AND REMEMBER THAT GRAIN CAN ACT LIKE QUICKSAND, COLLAPSING AND SUFFOCATING PEOPLE IN BINS AND TRUCKS.

ADDITIONAL IMPORTANT SAFETY RESOURCES

Auger safety: http://www1.agric.gov.ab.ca/$department/newslett.nsf/all/agnw24079

Grain handling safety: https://www.osha.gov/SLTC/grainhandling/
to pests. Landscaping should be minimally attractive to pests (i.e. no fruit trees). If lighting is included, it should avoid the ultraviolet range, which attracts insects (sodium vapour are better than mercury vapour lights).

All bins, as well as handling equipment such as augers, transfer equipment, ducts, exhaust systems, drying and/or aeration devices, aeration floors, and electrical equipment such as fans and ventilation, etc. must be thoroughly cleaned to remove all previous grain, dust, mould, insects and debris before bin filling. Commonly, high-pressure air, brushes and brooms, and grain vacuums are used to assure a thorough cleaning. If high-pressure water is used, all surfaces must be completely dry before grain contacts them.

Bins should seal completely to prevent access by water and insects. Vent holes should be covered and not allow access by birds. All holes, cracks, and seams should be sealed with food safe and strong material before grain is stored in the bin.

When filling the bin, try to keep the surface level. This allows better aeration. If the grain peaks at the centre, airflow will tend to move around the peak area, and moisture and temperature will tend to be higher, resulting in a higher probability of insects and spoilage.

**MOISTURE AND TEMPERATURE**

Spoilage is more likely to occur if temperatures are high, e.g. above 20°C, and if moisture levels are high, e.g. above 15%. Moisture levels that are considered acceptable for storage are indicated in Table 1. Higher moisture levels may be tolerable if temperatures are cold, but will be challenging once temperatures increase.

If grain is harvested above the desired moisture level, it should be brought down to the appropriate moisture content. If the bin has aeration, this should be used, provided that ambient air temperatures are below 20°C. Otherwise, grain should be dried before binning. Temperatures for air in the dryer can be up to 65-70°C for cereal grains, but grains themselves should not exceed 45-50°C; 30-32°C for delicate crops such as faba beans, where faster drying may result in cracks in the seed coat. Peas should not be dried above 45°C if used for seed. Never dry lower than 6% moisture, as this can result in shattering in many grains. Corn and oilseeds such as soybeans and canola are most prone to drying damage.

Lentil varieties with green seed coats discolour over time, reducing their grade. Lentils should be stored in dry and dark conditions to slow this process. Lentils from different years should not be mixed, as older seeds will be more discoloured. In general, lentils should not be stored through a second summer.

Dried grain is much less likely to spoil due to composting, insect or mould action. However, reducing the moisture content below specification results in a loss of weight which translates to lower returns. For instance, wheat dried to 10-11% moisture is less likely to spoil than wheat at 14-15%, but it is also 4-5% lighter, resulting in a 4-5% loss in payment when marketed.

Dryers can be a fire hazard, and must be kept clean. They are also more effective when airflow is not impeded with dust and debris.

Once grain has been dried, it should immediately be cooled to within 5°C of ambient air temperature. If the temperatures change markedly, this can result in areas of condensation within the grain mass, producing moisture pockets where spoilage is more likely. Even sunny days can result in temperature gradients, as the sunny side of the bin heats, but the shady side does not. Temperature gradients can be reduced by aeration. Be sure that the temperature front has moved entirely through the grain before stopping aeration, or moisture cells can develop. Where aeration is not possible, the grain can be ‘turned’, by emptying the bin and refilling it. This will equalize temperature and moisture in the bin.

Grain is a good insulator. As ambient temperatures drop in the fall, grain in the centre of the bin will stay warm longer, resulting in convection currents in the grain. This can result in condensation. Aeration may be required, especially if the grain at the centre of the bin is more than 5°C different from the grain at the walls. Moisture is likely to accumulate near the top centre of the bin. Be sure aeration reaches this area.

**MONITORING**

Air temperatures change over the season, and this may lead to condensation, and moisture pockets within the grain mass in the bin. This can lead to spoilage. Monitoring temperatures allows the producer to detect possible condensation before it is problematic. Temperatures in the bin should be checked every 2 weeks, using probes or sensing cables. If these are not available, a metal rod can be inserted into the grain at the top, near the centre. After 30 minutes, remove the rod and feel if it is warm to the touch at any point. This would be an indication of heating and of potential grain spoilage. Aeration, or ‘turning’ the grain would be recommended. Samples should also be taken every 3 to 4 weeks to check moisture content.

It is also possible to monitor for insect pests with a variety of traps and probes. The Canadian Grain Commissions advises that bins be monitored for insects every 2 weeks until the grain temperature falls below 18°C, and monthly...
after this. Aeration and grain turning will reduce insect activity, if it is detected.

Insects and moulds are sensitive to temperature. Several resources suggest that temperatures below -5 to -15°C are lethal to insect pests; temperatures at -17°C will control insects in structures. Temperatures below 3°C will prevent mites from reproducing; below 18°C will prevent insects from doing so. Moulds are inactive below 0°C. However, Canadian insects and mites that attack stored grain on the Canadian prairies are more cold hardy than reported elsewhere.

Using cold weather to inactivate insects is better than having active insects; however, buyers do not want any insects in the grain. Cleaning grain, and drying it before binning will reduce insect, mite and mould numbers.

Monitor bins regularly between January and March, and remove any snow before it melts. When temperatures warm outside, temperatures also warm at the sides of the bin. This causes condensation, and the potential for damage to the grain.

Where rusty grain beetle is a concern, diatomaceous earth can be applied to grain as it is augered into the bin. This dust absorbs the waxy covering on their skins, causing them to dehydrate and die. Advise your buyer if you use this product.

**MARKETING SAMPLES**

For each bin, representative samples should be taken. One method is to take samples from each truckload as the grain comes in, mix them and then sample from this collection. Samples can be sent to prospective buyers. When preparing samples, split them and send one portion to the buyer, and keep an identical sample. The duplicate sample can be sent to the Canadian Grain Commission (CGC) to determine such aspects of quality as protein level, falling number, mould levels, toxins, etc. The CGC can be an arbiter if the buyer and seller do not agree on quality parameters. For information on collecting a representative sample, see [https://www.grainscanada.gc.ca/guides-guides/rs-er/trs-per-eng.htm](https://www.grainscanada.gc.ca/guides-guides/rs-er/trs-per-eng.htm) or for more detail, [http://www.grainscanada.gc.ca/pva-vpa/container-contenant/proc-301/proc3-0-1-en.pdf](http://www.grainscanada.gc.ca/pva-vpa/container-contenant/proc-301/proc3-0-1-en.pdf)

**SPECIFICATIONS**

Buyers can provide a list of their specifications. These may vary from buyer to buyer, depending on the final use of the product. Confirm with the buyer before comparing your sample’s characteristics to the specifications.

**TRANSPORT**

Transportation is the final stage of quality assurance. All transport vehicles must be thoroughly cleaned before grain is loaded. Augers should run full, and at slow speed for least damage to grain.

Lentil should not be handled when it is colder than -20°C to avoid chipping and peeling. Handling equipment should be gentle, with belt conveyors preferred over augers. Lentil should not be dropped from a significant height.

**SUMMARY – MAINTAINING QUALITY**

The Canadian prairies produce some of the highest quality organic crops. To maintain that quality from harvest to sale, it is important that management be ongoing. Storage facilities must be scrupulously clean. Before grain is stored, it too should be clean and dry. This will reduce the risk of spoilage from mould, insects, rodents, and birds. Grain should be monitored throughout storage, to assure that it remains dry and clean. In this way, the producer can achieve top prices for top quality, and bring healthy products to an eager market.
RESOURCES


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