2014 Malting Barley Supply – Challenges and Solutions

This year we received a reminder that the entire brewing industry is subject to the whims of Mother Nature. Brewers require not one but two critical agricultural ingredients, barley malt and hops, which even the best of times require great skill and some luck to grow and process at high quality. Alas, 2014 was most definitely *not* the best of times for North American barley growing. BSG President Ian Ward outlined the big picture in a recent Brewers Association Power Hour: with some exceptions, this next year is going to be a very bumpy ride with respect to our malt supply.

BA technical staff and Pipeline subcommittee members offer this communication to provide background about the current state of our malt supply. We hope you'll gain perspective on the overall supply chain that will help with your efforts to procure the malt you need to make great beer. We've also included tips and techniques to help you in your brewery.

On the Farm:

By now you've likely heard rumors or strident media reports of a catastrophe in which the crop was destroyed and no one will be able to make beer; here's what actually happened. In many U.S. malting barley growing regions, average to excellent growing conditions took a turn for the worse just before and during harvest. August rains produced very poor harvest conditions in western 2-row areas (primarily Idaho and western Montana). Up to 500% of normal rainfall fell in a two week period leading up to and during the harvest in Idaho – here's an interesting webinar of crazy Western U.S. and Idaho 2014 weather from National Weather Service that explains what happened, and provides an outlook for this winter. Continued rains hampered the remainder of the harvest. Heavy rains also fell in Montana and western North Dakota during peak harvest with continued lighter rain during the remainder of the harvest. Growers in Wyoming were largely spared this unusual weather and crop damage.

The extremely wet conditions created barley quality issues. High harvest moistures resulted in significant pre-harvest sprout damage, reduced storage ability and introduced the threat of *Fusarium*. Suitability for malting in many areas was so poor that growers chose not to harvest, settling for insurance pay outs instead. U.S. harvested area this year was down 20% from last year. Rain compounded the issue; only about 70% of the already small malting barley crop was selected for even a possibility of being processed into malt and of that 70% nearly half was compromised to some degree.

In Canada, a wet and cool start to the season delayed seeding, a hot July led to higher protein levels, extra moisture closer to harvest led to some increased *Fusarium*. As harvest moved north from Idaho and Montana and into Canada, the unusual moisture pattern followed with snow and frost causing sprout damage, significantly impacting suitability for malting. A decline in seeded area and the sharp decline in harvested area mean that Canadian barley production this year is estimated to be down

30.5% from 2013. The 2014 harvest is the smallest Canadian barley crop since 1968. Similar to the U.S. harvest, about 70% of the already small malting barley crop was selected for malting with a large percentage of the selected barley compromised to some degree.

Growers who harvested a marginal crop and then missed malt acceptance were forced to sell into the feed market. As of this writing, North American growers lost many hundreds of millions of dollars. For thousands of growers in the U.S. and Canada, 2014 will be remembered as a horrible year. The only silver lining is that looking forward, the malt to feed premium, currently as high as $7 or more per hundred weight (as of Nov 20 in Idaho) should encourage growers to plant malting barley in 2015.

In the Malthouse:

The quality of the 2014 barley harvest has likewise presented incredible challenges for most (but not all) North American maltsters, both operationally and financially. Because malting barley has evolved into a custom contract crop used primarily by the brewing industry, maltsters have to deliver pre-determined quantities of malt, at specified very high levels of quality and performance, at an agreed upon price. This year's barley crop will mean many maltsters will be hard pressed to deliver on quantity, quality *or* price, never mind simultaneously. At least one U.S. malting company will import barley from Europe to make up their quantity shortfalls and partially mitigate quality issues.

Several maltsters chose to provide valuable input for this communication. According to Whitney Thompson from Malteurop, "Barley is a very unique specialty grain in that the kernel must stay alive for, ideally, up to 16 months post-harvest. This year, U.S. and Canadian maltsters were forced to accept some portion of barley injured by sprout into their facilities. Our top concern at this point in time is ensuring that the injured barley is malted as quickly as possible to ensure that the kernel does not die sooner than expected." Cargill Malt representative Ron Ryan offered that "The 2014 Barley crop will definitely be a challenge for both brewers and maltsters. With some extra focus and attention, we believe the industry will be able to continue to produce World Class beers despite these challenges. If you have been looking for an excuse to get to know your maltster a little better and become more educated about your malt supply, this is the time." BA staff and Pipeline subcommittee members couldn't agree more.

As we read above, much of this year's barley crop was sprout damaged at harvest. High moisture levels in the barley require special attention during storage, where continued germination (chitting) can occur. Maltsters try to work through the damaged grain quickly in order to mitigate the risk of further damage, but the high proportion of sprout damage makes it impossible to malt all of that barley volume first or in a timely manner. In the malthouse, sprout damage results in decreased germination rates, and can result in poor modification of protein and carbohydrate components – in short, less than optimal malting.

Like brewers, maltsters have a few tricks up their sleeves learned during previous poor crop years which can partially (but not completely) mitigate some of these issues. Your maltster can for example alter his or her malting parameters to manage total modification and beta glucans by adjusting the number and duration of steep cycles, steep temperature, aeration levels, end-of-steep moisture, germination temperature or time. Such changes might result in costly increases to total malting cycle times. Maltsters who don't normally employ processing aids such as Gibberellic Acid ("GA") may simply have to do so this year to produce malt with reasonable brewhouse performance. Your brewery may or may not

care about GA, but if so be sure to ask your maltster. If you produce organic beers, be sure to ask your certifier about GA.

As Whitney Thompson commented, "Although this year's crop is far from ideal, we are taking all steps to ensure that all of our malthouses perform to the best of their ability for the brewer. As maltsters, we are continuously working as a team to produce the best quality malt, with the barley we have, for our brewers." This coming beer production year will test the maltster-brewer relationship like few times in the past. When the dust settles on 2014 crop year malt and the 2015 brewing production year, maltsters will deserve a lot of credit for skillfully supplying brewers with malt of sufficient quality and quantity to make great beer.

One 2014 crop bright spot mentioned above was Wyoming, whose growers were largely spared untimely moisture during harvest. According to Briess Malt and Ingredients Vice President Bob O'Connell, "raw malting barley grown for us this year by Wyoming and Montana barley growers is very high quality, and yielded well. Our raw malting barley did not experience the loss of quality that much of the North American crop did."

In the Brewhouse:

Brewers should prepare for quality issues in much of the malt derived from the 2014 North American crop. Poorly modified malt can lead to significantly decreased extract, long conversion and lautering times, poor beer stability, and occasionally off-flavors in finished beer. Protein levels are expected to be up on average 0.5% to 1% from 2013 crop to 11.5 – 12%. Sprout and frost damage will lead to higher beta glucans. Excessive proteins and beta glucans can cause a beer to throw a haze, reduce mash efficiency, decrease a beers' stability, and increase total processing costs. Extract will likely be down 0.5 – 1.0%. Highly variable malt modification and performance is likely. Processing aids may be required to produce malt with reasonable brewhouse performance.

What can a brewer do? The problems created by this year's poor quality barley harvest, while inconvenient and potentially costly, are not insurmountable. Here are proactive steps you can take to address problems you might encounter:

- Don't blame your maltster, or your grower. Have a beer, it'll definitely help your attitude. If you must blame anyone, curse at Mother Nature. Likewise, be sure to thank her when your malt supply returns to normal.
- Request an *actual* lot analysis if your maltster doesn't automatically provide one. The variability in this year's supply will render an *average* or *typical* lot analysis worthless.
- Then, *learn how to read and understand your malt analysis, and act upon it*. The November / December 2012 issue of The New Brewer has a great primer on reading a malt analysis, whether you are learning this skill for the first time or just brushing up. The newly released Brewers Publication Malt: A Practical Guide from Field to Brewhouse has an excellent section on reading a malt analysis as part of outstanding barley malt knowledge from author and Technical Committee Co-Chair John Mallett.
- *Communicate with your maltster*, ask questions and listen closely to their advice.
- Be aware that the beta glucans number measured by your maltster won't always correlate with filterability in the lauter tun or finished beer. The beta glucans number shown in your malt analysis is a start, but the assay is a relatively blunt instrument that won't show the

distribution of carbohydrate molecular weights within your malt. Remember – your maltster is also working hard to manage beta glucans.

- Anticipate decreased extract from your malt. Your flagship brand might need an extra bag of malt to hit your target gravity.
- Anticipate extract variability. Check gravity far more frequently than usual, especially as you approach full kettle. If your gravity is low, consider collecting a lower than usual wort volume on the current batch, then add more malt to your grist in future batches to compensate (see above).
- Think, and plan. Malt is bulky and weighs a lot. If you find yourself using 2% or 5% or 10% more malt in a recipe, be sure to order more malt and keep more on hand to fulfill your production requirements. Likewise think about your increased spent grain disposal volume.
- Pay attention to pH. This is important in a normal malt year, but absolutely critical in a year like this one. If you don't own a pH meter, get one. If you have one, dust it off, and buy a new probe and reference solutions. Pay attention to your water analysis, especially hardness and pH. Treat your water aggressively using food grade phosphoric or lactic acid to ensure that your mash pH is in the optimum range (5.3 - 5.4 when measured at 77 ^{o}F; 5.1 – 5.3 when measured at 149 ^{o}F) to maximize diastatic power.
- Manage your mash pH very closely. You can lower mash pH by acidifying your water (see above), by adding darker malts, by making a sour mash or adding acid malts. Enzymatic activity decreases rapidly with a pH that is much above or below this range. In normal years, there is more than enough enzyme to go around; this year, you'll need to pay close attention to maximize what's there.
- Consider modifying brewhouse procedures, especially your mash cycle, to address higher beta glucans and protein levels, especially if you are pulling your hair out over repeated stuck mashes or blinded filtrations. The single most effective step you can take in the brewhouse is to add a protein rest to your mashing program. Protein rests are effective at 120 – 130 degrees ^{o}F, at a pH of 4.2 – 5.3 for 20 – 30 minutes, and at a far thicker mash consistency than your conversion rest. This is relative simple in a jacketed mash tun equipped with mechanical stirring. But even in a 7- or 10-barrel mash-lauter combi-tank, you CAN add a very effective protein rest via underletting, a long paddle or stirrer, and some sweat and elbow grease. Try mashing in with 130 - 135 ^{o}F water to achieve a very thick mash in the 120 - 130 ^{o}F range. Be sure to check your pH and treat your water to achieve the right pH. Wait for 20 minutes or so, then underlet with 180 - 200 ^{o}F water (or even hotter) from your liquor tank or kettle. Underlet slowly and with plenty of stirring to raise the thick bed, break it up into a uniform thinner mash, and stop when you hit your desired conversion temperature (or perhaps just under, you might find your temperature climbs a bit more as the very hot water migrates out from under the screens).
- In extreme cases, a beta glucan rest is effective at 113 – 122 ^{o}F for 20 minutes. Again, easier to do in a jacketed, stirred vessel, but nonetheless possible with some trickery and planning in a mash-lauter tank. The lower end of the protein rest range shown above around 120 – 122 ^{o}F will also overlap with a beta glucan rest, so you may be able to kill two birds with one stone.
- Be prepared to adjust your conversion temperature up or down to achieve your usual attenuation levels, and be prepared for this temperature to change with your malt over time due to consistency issues.

- Be prepared for your conversion times to increase with lower malt modification. With under modified malt, and especially if your wort is not attenuating as far as usual during fermentation, consider managing your conversion temperature below 152 ^{o}F to maximize beta amylase activity, with a slightly higher pH than shown above, ranging from 5.1 - 5.3 at 149 ^{o}F. Your conversion might take a little longer than usual, but your wort might attenuate farther than it would otherwise.
- Be prepared for your lautering times to likewise increase with lower malt modification.
- Consider using rice hulls in your mash to increase bed permeability and decrease runoff times.
- Be sure to benchmark your fermentability closely. Document the original gravity and final gravity of your flagship brands. The difference between these two figures is a huge decider of flavor in your beer. You'll especially need to pay attention to fermentability if you implement increasingly intensive mash programs. Deviating from your usual mash program might change wort FAN levels (which could in turn affect yeast health and filterability), might alter filterability of finished beer, and might change head retention. These outcomes might simply be unavoidable – there's no free lunch. In short, don't be surprised if your brand wanders from its normal flavor path.
- Consider brewing aids and enzymes which are specifically formulated to reduce production and quality issues associated with difficult malt in the mash. Preparations can include glucanases (enzymes which break down high molecular weight carbohydrates such as beta glucans), proteases (enzymes which break down high molecular weight proteins), alpha amylase (more of the enzyme normally found in barley which convert your mash), or combinations of these. These brewing aids are not a magic bullet. You may or may not save money by increasing your extract and decreasing your labor time; you may or may not have greater consistency batch to batch; and you may or may not care about the origin of the enzymes. A quicker runoff might be balanced by a detrimental outcome at the filter (Agu, R.C.; *MBAA TQ* **2005,** 42(3), 199-203). But if you are willing to experiment a bit, you might realize a net benefit that lets you sleep at night and lowers the stress level at the brewery. Ask your supplier questions about their products to chart the best course for your brewery.
- Consider blending different malts into your normal malt blend or recipe. The 2014 barley harvest in most of Europe was generally of good to very good quality. The added expense of imported grain may be offset by low yields and increased production costs associated with the 2014 North American crop. You might find that even a small proportion of less problematic malt makes a very big difference in your brewhouse. Analyze your situation to develop the appropriate plan for your brewery. In any case, be willing to try combinations of different malts.
- Consider increasing your kettle finings, and/or trying combinations thereof.
- Consider processing aids such as (in alphabetical order) gelatin (old school yet very effective – be sure to specify 200 or 225 Bloom for beer), isinglass, PVPP and silica, or combinations of more than one. All will lower the polyphenol or protein content of finished beer, increasing filtration efficiency and contributing to increased package beer stability. Even if you've shunned these in the past, there's nothing like hazy 2-week old package beer or a 6-8 hour filtering run on your 2 square meter DE filter, to change your perspective.
- Be aware of gushing and DON. DON is produced by *Fusarium* fungi species growing on barley; such disease is also referred to as Fusarium Head Blight (FHB) or scab. Because your maltster

normally manages DON by rejecting affected barley, you may never have even heard about this potential issue. But since all-malt brands are more prone to gushing, and this year's crop showed more evidence of DON than usual due to higher moisture growing conditions, it's good to familiarize yourself with the potential issue.

- Be flexible. Be open to trying ANYTHING that gets you to the happy place of consistent, great beer.

This coming year will reward the curious brewer who is willing to take a deeper dive into his or her craft. There are many sources of information you can access, starting with your malt supplier technical staff. The American Malting Barley Association (AMBA) has very helpful information on their website, ranging from malting barley basics to in-depth presentations. You can also learn about malt and the brewhouse in the back catalog of the MBAA Technical Quarterly (membership required to view full articles). Here are a few articles out of dozens you will definitely find helpful:

Barley Basics: Hertrich, Joe; *MBAA TQ* **2013**, 50(1), 29-41
Malting Basics: Hertrich, Joe; *MBAA TQ* **2013**, 50(4), 131-141
Beta Glucans: Jin, Yu-Lai et. al.; *MBAA TQ* **2004**, 41(3), 231-240
Effects of Barley Protein on Malt and Beer: Leach, Richard et. al.; *MBAA TQ* **2002**, 41(3), 191-202
Perspective on the Brewer/Maltster Relationship: Bamforth, Charlie; *MBAA TQ* **1999**, 36(3), 301-306
Gushing and DON: Casey, Greg; *MBAA TQ* **1996**, 33(4), 229-235

Annual variability of barley and malt is a fact of life; this year will be especially challenging for many brewers and maltsters. With knowledge, foresight and planning, brewers can negotiate the challenges presented by the 2014 North American barley crop, and make great beer. As you look ahead to 2015, ask Mother Nature to provide for an early seeding window and a dry harvest. And with world barley ending stocks settling close to historic low levels, be prepared for world malting barley pricing to most likely increase rather than decrease.