



 HPA


**VIRTUAL
HARVEST
2021**

Quality assurance in hop production

Owen Johnson: G'day, welcome to the labs at Bushy Park Estates, Tasmania, Australia. I'm Owen Johnston, Head of Sales and Marketing here at HPA. Joining me is Nathan Calman, brewery manager at J. Boag and Son, the Lion brewery here in Tasmania.

We're going to dive into the science behind quality management with our Quality Manager, Peter Hamilton, and our lab coordinator, George Webster.

Peter Hamilton: We take pride in our hops and the beers you make with them, that's why we have a no-nonsense quality management system. It's ISO 9001 and HACCP certified, so brewers can be always assured they're going to get high quality Australian hops.

OJ: Quality starts on the farm. We have a team of 20 people spread across the business who are tasked with maximising the quality of our hops from the buyer to the final package, and this lab is the centre of it all.

George Webster: We have labs on each of our farms, and they have a pretty high throughput over harvest, so it's important that our methods are easily repeated and very robust. In the lead up to harvest, the quality team move through every garden three or four times, taking a representative sample of hop cones from the bines to determine when each sample will be ready to be harvested. This is done by regular analysis of gland fill, cone weight, dry matter, alpha acids, beta acids, and oils.

OJ: G'day George.

GW: G'day OJ. G'day Nathan.

Nathan Calman: As we're heading into harvest, what are the indicators that tell you a variety is ready to start picking?

GW: One of the key indicators is maximum accumulation of alpha acid with maximum accumulation of oils, so it's a process of metabolite accumulation that occurs through hop maturation, and that's through from the flavonoids to the alpha and beta acids to the sesquiterpenes and monoterpenes, and finally oils.

OJ: We also need to consider dry matter and cone weight to achieve an economical yield. When a variety is ready to harvest, it goes through our standardised production process to ensure hops meet our specifications every step of the way.

PH: Nathan, the first stage in the process is picking. We conduct extraneous matter tests regularly throughout each shift. This involves separating the hop from the stem and leaf and weighing both. The results of these checks are generally under 1%. If that number starts to creep up, we know we need to adjust the speed of the picker, the speed of the fan, or the angle of the dribble belts to get it back down again.

NC: How deep do you need to fill the kiln here before you start the process?

PH: We fill the beds up to 600ml, we fire the burners up to 65 degrees, and then we dry the hops between 8 and 12% moisture. This can take anywhere between 8 to 12 hours, so we check the moisture levels after 8 hours, then more and more regularly from that point on, until they are in spec.

NC: I've seen the operators wading around here through the hops, how do they measure the moisture level during kilning?

PH: They use a moisture metre, and they walk in a diamond pattern across the floor, so they're measuring from the centre out to the extremities of the kiln floor. As soon as the probe returns a reading within the target range, the burners are turned off and the floor is cooled, and then the hops are dropped onto the conditioning floor where they rest for at least 12 hours to allow the heat and the moisture levels to distribute evenly.

NC: What happens to the hops next after that 12-hour period?

PH: We press them into bales that have strict temperature and moisture specifications. Moisture must be between 8 and 12%, and temperature must completely stabilize before we transfer them to our warehouses. Any bales that don't meet these specifications remain in the processing facilities for corrective action. We allocate a different lot number to every pallet, which is equivalent to 6 x 110kg bales, and conduct auger sampling on every lot number to confirm it is in spec.

GW: This year we have a new lab setup next to the bale press so we can get results for alpha acid and oil contents in a much quicker fashion.

NC: That's got to be really good for quality, doesn't it?

GW: Yeah, it means we're producing hop storage index values for every bale that comes through, which will give us better quality outcomes in the blends.

NC: What sort of lab methods do you use to analyse your auger samples?

GW: We use a few different pieces of equipment. In the past we've used lead conductance value to produce alpha acid content, but we've since phased that out for sustainability reasons. Now we use near-infrared spectroscopy, which is much safer and more efficient. We've been running NIR in parallel with the ultraviolet spectrophotometer, distillation and moisture analysis, to continuously improve the accuracy our model.

The UV spectro analysis gives us our alpha and beta acids, as well as our hop storage index, and the distillation apparatus gives us our oil content. But this is a relatively slow, manual process. It takes around three hours per auger sample, whereas NIR is faster, indirect, and only takes about five minutes per auger sample, since no analyte extraction is required. With NIR we have been able to increase the number of oil components we can analyse, from six samples a day to 60, and we now have the capacity to produce oil content and HSI values for every bale during harvest, on top of alpha content. NIR is also employed for all our pre-harvest analysis.

PH: Nathan, once the bales are in spec, we use digital thermometers to measure the temperature of the pellets also throughout the process.

NC: Is there a point in this process where it's really critical to maintain the temperature?

PH: That would be where the powder passes through the die, at which point it should be a maximum of 55 degrees Celsius to make sure the pellets hold their shape in the final package. We also conduct hourly density checks for the same reason.

Once they've been cooled, the pellets are packaged into oxygen barrier laminated foil pouches, from which the oxygen is evacuated before being backflushed with carbon dioxide and sealed. The seal is currently checked by visual

inspection, and a Haug leak detector to make sure that there are no leaks to increase oxygen levels in the foil. And we use a gas analyser to test the carbon dioxide and oxygen levels within the foil.

NC: So you've got a really strong focus on maximising the benefit of your hops in the finished product. There's often a long time between when your hops are packaged here and we brew beer with them, what do you do in that period to make sure the quality of the hops is maintained?

PH: Our packaged hops are transported to warehouses across Australia where they're stored between 0-5 degrees Celsius until they are called up by the brewers. We have long-term relationships with our warehouse contractors, who all have climate monitoring systems in place. We also include them in our annual internal audit to ensure the conditions continue to support high quality in the final package.

OJ: I think you'll agree, the way the brewers use hops has changed significantly over the years. It's more important now than ever to understand the information we present from our quality checks. Every box has a lot code that links back to a certificate of analysis. It's the COA that has a standardised presentation of information relating to alpha, beta, oils, moistures. It's a way for brewers to measure slight differences year on year, or lot by lot, so they can adjust their recipes accordingly.

PH: The lot number also allows for complete traceability, from where the hops were grown to how they were sprayed to when they were harvested and how they were dried. That level of details ensures we adhere to the chemical guidelines of countries around the world.

OJ: Every aspect of our quality management system is designed to ensure only the highest quality hops get into the hands of brewers. We're continuously investing in quality improvements so you can get the maximum flavour out of our hops and continue brewing – and drinking – consistently delicious beers.

PH: Hi, I'm Peter Hamilton, Inventory and Quality Manager at Hop Products Australia.

GW: And I'm George Webster, Laboratory Coordinator. Thanks for showing an interest in our quality management system. We are keen to show you how this system is vertically integrated into our business so we can consistently offer brewers high-quality Australian hops.

PH: At HPA we are committed to quality with our no-nonsense quality management system that is ISO 9001 and HACCP Certified. Certification from independent testing institutes ensures our hops are held to the highest quality, safety, and responsibility standards. Our production process is subject to regular internal and external audits, so we continue to uphold these standards as well as identifying opportunities for improvement.

GW: Hop Products Australia is certified to ISO 9001:2015. We're certified to HACCP, Kosher, we are allergen free, GMO free, irradiation and fumigation free. All these certificates are available on our website.

ISO stands for International Standards Organisation. At HPA we are certified to the ISO 9001:2015 standard. ISO 9001:2015 is an international standard for quality management. Certification guarantees we comply with regulatory processes, product, and service requirements. It improves brewer experience by ensuring products meet expectations and is based on the Plan-Do-Check-Act, or PDCA model.

Plan stands for review where we are and where we want to be. This includes consideration of brewer requirements and risks. Do: implement the plan with correct training and equipment. Check: measure how we have gone, we did what we planned. Act: review our performance and use what we've learned to improve for the future. The PDCA model creates a framework for continued improvement.

HPA is certified to HACCP. HACCP stands for Hazard Analysis and Critical Control Point. It is a science-based system that identifies, evaluates, and controls hazards to ensure food safety. Some of these hazards include biological, chemical, physical, halogen, regulatory hazards. HACCP is compliant with other domestic and international food safety management systems. Because of the HACCP system, brewers can have complete confidence that our hops are safe to add to their beer.

HACCP is based on seven key principles. The first principle is hazard analysis. We identify the hazards, the severity, and the likelihood that it will occur. The second principle is CCP determination. We categorize the hazards into what we call Critical Control Points, or CCPs, or Control Points, CPs, based on the severity and the likelihood of the hazard.

CCP critical limits are set for all our CCPs and CPs that allow enough time to correct before the limits are reached. We establish a system of procedures and records to monitor our CCPs and CPs.

Hop Products Australia has a system of corrective action if monitoring shows a CCP or CP is not under control. This system identifies who is responsible to correct, what action to take to re-establish control. We also have procedures that verify the HACCP system's working, for example the lab testing, internal and external audits, physical assessments, etcetera.

HPA has a documentation system that show HPA's HACCP plan has been effectively managed and implemented. Some examples of these documents are our HACCP plan, meeting minutes, product descriptions, hazards analysis, corrective actions, and HACCP training records for our operators. HACCP is focused on prevention rather than relying on end-product testing.

We receive our ISO and HACCP certifications from Standard Global Services, or SGS. SGS is the world's leading inspection, verification, testing and certification company. They ensure our products, processes and services comply with international standards and regulations. Certification from an independent testing institute provides brewers with objective assurance that our hops are held to the highest quality, safety, and responsibility standards.

HPA is Kosher certified. Kosher is a term used to describe food that complies with the strict dietary standards of the traditional Jewish law. HPA is audited annually by Kosher Australia. Kosher Australia is widely recognized as the leading Kosher certification body in Australasia. Stamp of Kosher approval by a Rabbinic agency verifies they have checked our hops, production facilities, and processes to ensure all ingredients, tools and machinery have no trace of non-kosher substances. Certification authorizes us to use the Kosher symbol in our literature and all our packaging.

There are three steps to Kosher certification. Firstly, we complete a certification checklist that provides Kosher Australia with key information. Kosher Australia then audit our sites, they then determine the condition of certification based on the checklist and the audit.

Our allergen statement verifies we have checked our hops, production facility, and processes to ensure all ingredients, tools and machinery have no traces of the following allergens: gluten-containing cereals, other than those that are present in beer and spirits, crustacea and their products, eggs and egg products, fish and fish products, milk and milk products, tree nuts, sesame seeds and their products, peanuts, lupin, soybeans and their products.

On our website we have a GMO statement. Our GMO statement verifies that our hops are neither genetically modified, nor have the resulting hop products come into contact with genetically modified organisms, or GMOs, during the production process. This statement is made voluntarily and is subject to relevant Fair-Trading Laws, which prohibit representations about food that are false, misleading, or deceptive.

The Australian hop industry is fortunate to be free from any damaging pests and diseases that affect hop production overseas. We adhere to an approved list of agrichemicals in accordance with safe storage and handling procedures. We also have an approved list of food-grade grease and lubricants that are used on any machinery that comes into contact with our hops.

Each season we analyse our hops for agrichemicals and heavy metals. Our chemical analyses are performed by Agrifood Technology, who test for 265 agrichemicals. Agrifood Technology are approved by the National Association of Testing Authority, or NATA, and are ISO:9001 Certified. We analyse one sample for every 40 tonnes of hops, ensuring all varieties and growing regions are represented.

Our heavy metal analyses are performed by a NATA accredited lab who test five random samples representing each growing region for arsenic, lead, cadmium, mercury, nickel, copper, iron, selenium, chromium, and cobalt. Our hops do not go out to the brewers until the results come back. If MRL or heavy metal analysis come back above the accepted levels, the affected hops are isolated, we re-test the original sample to confirm the result, and take further samples to ascertain the extent of the issue.

We are able to trace the use of agrichemicals using our paddock log records. Our paddock logs provide complete traceability. Traceability that goes all the way back to which garden they came from, the specific batch of

agrichemicals they were sprayed with, as well as the machinery used for application. In 2020, no agriculture chemical residues or heavy metals were detected above the global best practice maximum residue limits, or MRLs.

To make sure our systems are working correctly, we conduct internal audits of our quality management system, processes and procedures every year. We are subject to external audits by Kosher Australia, SGS Australia, during our annual ISO:9001 and HACCP certification. We also complete 10 to 12 desk audits for various customers per year. We were audited by Lion in 2020 and CUB in 2019. We have also been audited by Kirin and Heineken in the past.

I'll now hand you over to George to discuss some of our other quality innovations.

GW: Thanks Peter.

Here at HPA it's our mission to deliver the highest possible quality with the lowest possible variance in flavour. But the way brewers use hops has evolved over the years and we're still discovering the quirks of newer hopping regimes by constantly reviewing our nutrient regime, water management and harvest timing to maximise hop flavour in beer. There's a fine line between the accumulation of big thiols and small thiols, which means the shift between fruity and onion, garlic flavours can happen quickly.

The popularity of Galaxy means we're constantly pushing the boundaries on late harvest so we're working harder than ever to tighten up our processes as much as possible. We're now using NIR analysis to tighten our harvest windows by obtaining more information per sample, and we have been conducting more in-house brewing trials to improve our understanding of how each hop performs in a range of beer styles.

HPA's in-house brewing trials will help us offer valuable technical advice to brewers. In order to preserve the impact in beer, we seal our hops in oxygen-barrier laminated foil pouches that have been backflushed with carbon dioxide. Unopened foils will last up to three years in storage at temperatures of 1 to 5 degrees Celsius. We have observed that storage stability varies from variety to variety, and that once the foil is opened, the oxidization of alpha acids begins almost immediately.

Each hop has different levels of natural antioxidants and varied susceptibility to oxidation. While this can cause them to lose quality faster, even under identical storage conditions, we do know that not every foil is used in its entirety as soon as it's opened. Once oxidation commences, the more volatile oils, such as myrcene, are rapidly lost, and the higher the temperature, the more they will degrade. Additionally, hops exposed to high levels of UV light can produce off or cheesy flavours in beer.

There are some simple and cost-effective steps that brewers can take to keep their hops fresh and their beers consistent. Step one is to refrigerate hops in storage temperatures between 1-5 degrees Celsius. Hops exposed to high temperatures can rapidly degrade and this degradation can be reduced by half for every 15 degrees Celsius drop in temperature.

The compact shape of hop pellets keeps out a lot of the oxygen and allows them to be easily vacuum packed in order to slow the loss of alpha acids and oils. They can also take up less storage space, making it more practical to keep them in the fridge.

Step two is to reseal open foils. We recommend the use of a commercial chamber vacuum sealer. Two key features a brewer should look for in a vacuum sealer are the ability to comfortably hold a 5kg foil and a pre-installed inner-gas backflushing capability, or the option to fit a separate gas backflushing kit. These devices typically start at about \$5,000.00 Australian when brand new, but you can often source them second-hand from restaurants. They're a particularly good investment for those with brew pubs, as it can be used in both the brewery and the kitchen.

Ideally brewers should reseal the original foils to retain the benefits of the oxygen barrier. Hops in resealed foils should last up to two months, depending on the variety and the overall exposure to oxygen. We would say the next best thing is a commercial-grade vacuum bag. If vacuum sealing is not an option, brewers should simply squeeze all oxygen out of the foil and then wrap and tape it as tightly as possible to eliminate the presence of oxygen. Ideally, once the foil is opened, the hops should be used within a few days to minimise the loss of alpha acids and oils and maximise impact in beer.

Finally step three, date and time stamp open foils. Again, it is worth re-mentioning that hops resealed in their foil last up to two months. If hops are not resealed in their foils, brewers should label them with their variety, lot code, crop year, alpha acid percentage, and weight to help determine their expected impact in beer at the time of use.

Thanks for being part of this session. Now we're going to head straight into a live Q&A with Nathan Calman from James Boag.

OJ: G'day, thanks again for joining us for a tour around our quality systems. We seek to have this vertically integrated quality system to make sure that we, this team and our on-farm team, can deliver you, the brewer, the highest quality hops that we can.

Again, very fortunate to be joined by Simon and Pete today, and Nathan Calman, up at the Boag's brewery in Launceston, welcome. Thank you for joining us, mate.

NC: Great to be here, OJ.

OJ: Mate, really appreciate it. Really appreciate how much time you've made available for us to join us on farm and now for the live Q&A chat.

Nathan's been working for Lion since 2007 and has had quite a journey and, for me, a fascinating series of roles in the Lion organization, coming in as a part of the Innovation and NPD team, spinning off into production at Toohey's, one of the big Lion breweries here in Australia, before moving down to the J. Boag & Son brewery in our home state of Tasmania, which has gone through a number of changes. Nathan, you've held a number of roles right in the brewing stream there and in manufacturing, and now heading the team up as Brewery Manager, encompassing a range of things: plant equipment, logistics, site management as well as oversight of the brewing operations. Is that a fair and accurate description of your quite wide remit in your current role?

NC: Yeah, definitely OJ. It's pretty broad these days, but still have brewing at heart.

OJ: I hear you. And it's probably only meaningful to me, but very early in my beer journey, one of my lightbulb beers was Boag's Premium. Probably still the flagship beer produced there at the Boag's brewery, and still going strong today many years after enlightening me to the joys of beer.

NC: Good to hear.

OJ: You've met Pete in our videos. Pete is Quality and Inventory Manager here at HPA. Talking about background, a journey through an Ag Science background and into our farms, in our northeast Victorian operations very early on in the early 90s. Basically he's followed a career in the hop industry in this company in its different forms and has been in a role here at headquarters for...

PH: Since 2003. Been in Hobart for that long.

OJ: That is fantastic. So being with HPA for over 30 years lending his expertise and experience to some great outcomes. Thanks for making yourself available, it is the middle of harvest and these guys both have actual on-farm responsibilities, so I am deeply appreciative of you guys making time for us.

PH: Thanks, OJ.

OJ: And now Simon you've met in previous iterations, famous from such videos as "Let's Meet Eclipse" and "Welcome to the Breeding Program". Please check them out as Simon shares a bit more of his in-depth knowledge of those topics that are close to our heart. Simon has a background in Agricultural Science and holds a PhD in Quantitative Plant Genetics, has been with the company since 2007 leading up our breeding program and is our go to for all things hop science, and our expert in hop breeding. Thank you, mate.

SW: Thanks, OJ.

OJ: First, though, we're going to give you a little bit more insight into our program. Simon, in George's absence – we've had a late change to the line-up today, George and his family have welcomed a new addition – so Simon's on the hook for this.

In the video, George speaks to quite a high throughput through the labs. Roughly just recap for us, roughly how many tests and results does that lead to?

SW: I think across all of our production sites, it tallies up to about 3,500 individual samples in the production system every year. I think it maps out to 60,000 individual measurements taken across those 3,500 samples.

OJ: That's across those pre-harvest and in-harvest variables that we value: dry matter, cone weights...

SW: Dry matter, cone weight, oil content in pre-harvest, then moisture and oil content, and alpha acid, beta acid accumulation and hop storage index in all of the processed products, so bales and pellets.

OJ: Those, in terms of decision making, we rub those five or six variables together in pursuit of that picking window optimal quality?

SW: Yes. We use it to manage the sequence of paddocks to get the optimal, try and hit the targets for each individual paddock the best we can and then, obviously, heavy reliance on the information on the processed product to manage the blended varieties.

OJ: I guess we're a little off topic, perhaps, but that decision on harvest window and paddock sequence, it's a collaborative decision between...

PH: Me and Simon.

SW: There's a few of us that have roles in that one. And necessarily so, there's often a little bit of angst about it, too, because you've got competing interests, if you like. There's the pure logistics of farm operations, some things are easier to do than others, so the best outcome welcomes different opinions.

OJ: Exactly, you've got considerations about operational issues like labour force management, the rate at which a farm manager can get across the ground and execute a harvest window, through to the quality concerns, adherence to issues, quality system-based issues, like whether there're going to be holding periods, etc. Then the laboratory-based guidance, or information, that we all feed into that.

SW: It's not a hard, fixed decision matrix. It's not something that's terribly amenable to that. There's lots of people involved in trying to massage that into the right shape.

OJ: Moving on from that, we're coming to the tail end of quite an aggressive expansion in our own production base, have there been any changes in lab methodology to assist in quality as we expand?

SW: Yeah, the biggest one is really urgent, why George came to business with HPA. A few years ago, we decided that we needed to increase our analytical capacity to improve our production control from bale product, particularly targeting oil content for blending. We committed to developing indirect analysis through Near Infrared technologies. George came to the business with a remit to do the work, to do the fundamental work to develop the models that would allow us to do that.

We worked with a company in New Zealand called SAGITTO and we now have the capability to analyse a hop sample and get ASBC spectro, alpha acids, beta acids, hop storage index, moisture content and oil content from a single scan in about three minutes.

OJ: From one sample prep, three minutes later you can have that amount of data behind those variables?

SW: Yes, and a normal industry standard, essential oils contamination, would normally take 3.5-4 hours.

OJ: I may guess for the audience as well, the model is a series of correlations between NIR information backed by wet chemistry, actual distillations, and correlating those?

SW: There's some fancy maths that take the spectral profile of the sample and relate that to the analytical data of the hops – I can't remember the number of samples there are in the system now but coming up to four years' worth of data in that system.

OJ: As soon as Simon said fancy maths, my eyes just go...

Tell me again, going back into your original answer of your motivations to moving to NIR was about oil. Why is our understanding of oil driving our assessment of our quality?

SW: It's that insight around that there is variability in oil content, both within a field and between different fields and at different times across harvest. We understand the variability within our varieties and the desire to produce a better, a more consistent pellet product, and to do that we really needed to understand what the oil content in the bales flowing through the system was. With a four-hour distillation producing, each site can produce about 18 bales an hour on two 10-hour shifts per day, so that's a lot of bales coming through the system, and you just cannot keep up with traditional distillation methods.

OJ: Yeah, you'd have a whole hall filled with a distillation kit just try and keep up.

SW: And still get nowhere.

OJ: Management of our oil in the finished product is all about that seeking to present consistent, high-quality hops that do what we say they're going to do, that fulfilling the promise of impact in flavour. Managing our oil levels across, as Simon says, across the variability in the agricultural outputs is paramount to guaranteeing or ensuring that we can have an impact in a brewer's beer.

SW: And one of the things I think is cool about that is that all of a sudden that puts pressure on our agriculture and horticulture to deliver a higher base level, which I think is a fascinating challenge. You bring this technology in and you don't really know what it's going to do to the business.

OJ: Yes, beware the questions you ask.

It is also about HPA acknowledging that it's incumbent upon us to look after the brewers in that way, challenge our agriculture to put out a high-quality base, challenge our systems – analytical and inventory systems, and production methodology systems – to fulfill that promise, to deliver highest possible average oil, lowest possible variant in oil, across an entire crop.

That's a challenge, isn't it?

SW: Yeah, and if we don't have the information, we don't know what we've got to do it.

OJ: And this introduction of this technology has given us that edge on insight over what we previously had.

SW: Definitely, a huge amount.

OJ: Pete, your top-of-mind answer with introduction of NIR, we will get higher average, lower variance in the finished lots?

PH: That's right. It enables us to do a very fast blending, we're able to get data very quickly, it just helps all down the line right through the processing system.

OJ: So the capture of NIR we've seen at the bale press, that is literally effectively live-loaded into a database and you guys can see that information. This was not previously available to us.

PH: No, it used to be one to two hours before you got anything, now I'm getting it within one or two minutes.

OJ: Alright Pete, in the unlikely event that a brewer happens to get a problem and we field a quality-orientated complaint, what's the process? Where do we go?

PH: We take all complaints really seriously, so we have a quality management system. We record the complaint, we'll get all the details from the brewer of exactly what is the issue, what's the problem. We then have a system where we're able to trace back right through the process. We have a lot number system on each of the bales which gives us, we can get back to information like what was the alpha acid, what was the moisture.

We can even trace right back to the paddock where the hops actually came from. We can look at what was applied to that paddock, so we look at what chemicals were applied, what fertilisers were applied. It enables us to be private investigators and get right into it and get right into the information. We can find where the issue has gone, where

the problem is, and then we can feed back to the brewer what we're going to do to fix the problem so going forward we have a better-quality product.

OJ: We're quite brave, I would say, about our investigations and feeding back in our quality loop. A brewer that makes a quality complaint, they can have faith in us to adequately investigate it. And it's why Nathan's joining us in this way, because the door is open to customer audit. It feels like almost every week through harvest someone emailed at times, it's a bit limited this year, but someone's auditing us. Whether it's our ISO audits or Kosher audits.

PH: We're actually being audited tomorrow.

OJ: There you go. Which one is that?

PH: SGS.

OJ: That's pursuant to our ISO.

Can you give me an example where a quality complaint has come in and it has led to a change in the way we manage our systems or our outputs or our information?

PH: We had a complaint from a brewer who was pulling the foil out of the carton and was placing the foils around the brewery, and then went back to look at it and go, "Hang on, I don't know what variety that is, don't know what crop year it is." There was no information on the foil, we had all the information on the label. That complaint came through from the brewer saying, "I don't know what variety I'm putting in my beer," so we took that information on board and we now print crop year and variety on every single foil we produce.

OJ: I kind of appreciate that because it's a simple example, but for me it's about listening and about being prepared to adjust our somewhat older systems, an old infrastructure, to be honest.

I would say another example might be pellet density and uniformity and application in the brewery in dry-hopping situations. We listen to feedback about performance from brewers and whatever their needs are, and then we go back inside our lines and have a look at how we can address those.

Simon, just a question from the audience. Back on the NIR for two seconds, can you talk to us about accuracy? We talk about correlation between the wet chemistry side and correlating it to build a model, can you comment about accuracy against that?

SW: It's several levels, yeah. We have from the data science team at SAGITTO we have very precise statistical accuracies. We have a different model for each measurement, obviously. We have oils, we know where they sit, but we also have our lived experience, if you'd like. It's taken us, we gave ourselves a year of gathering data to build initial models, and then the concept when we went in was that we would have it running in the background on one site in year two and then in year three we'd be able to use it, then after year three we could make a decision about committing going forward.

The system proved to be so useful, and we were so hungry for that information on that timeline, that it got ahead of that three-year timeframe. Potentially in year three the models were a little green, and the problem with the accuracy at that point was the range of variability in the reference data that we had supplied to build the model. So for moisture, for example, to get accurate prediction across the range of moistures that we see in our bales we needed to have good analyses of lots of samples that were a lot lower and a lot higher than the working range that we saw.

OJ: I see. So you know you want to operate here, you need a model that's broader.

SW: That's considerably broader than that. We had it applied out there and were trying to use it and it took us a little while to catch up with that range of good, accurate reference data feeding into the model, which we have now.

We now have a reasonably accurate model across the working range that we like to work in in most of those variables.

OJ: For something like alpha, we only grow a certain set of varieties. Their alpha range is typically quite high in the global scheme of things, does it apply for alpha as well? We don't have hops in the European five-and-under percent alpha range, has that been troublesome in our model?

SW: Given that we don't come across those hops that often, not for us necessarily, but we are really, really sure to gather up samples from around the world, obviously different crop years are in there, so we can go samples from 2017 or 2015 even, find them and analyse them now so they contribute

We've had a bit of assistance from our partners here within BarthHaas Group here as well so we can get some European and North American information in. While I can't speak directly to having to use the system on European aroma hop production context, what we see when we run that type of sample is that the performance is good enough for the process control job that we want to do.

OJ: One last question on behalf of the brewer, if I could extrapolate, you're relying on the NIR, do you then back-check with traditional methods to make sure that that lot that I'm going to get is accurate?

SW: For our internal process controls to our bale monitoring, we back up every live, instantaneous NIR analysis with a [inaudible] moisture, for example, because moisture's the critical one in terms of stability and run ability and things like that, so every sample's still going through the oven. That's just an insurance position for us.

OJ: And is it the same, Peter, on finished pellet lot codes? So when a label goes on a box and the COA has this much oil, the NIR model is corroborated?

SW: It's the other way. We're still using ASBC spectro bi-solvent extraction.

PH: But for the labels we use the traditional methods, but we back them up with NIR.

OJ: This is probably, you might not have this number in your head, but for that finished lot, NIR oil versus ASBC spectro oil...

SW: Oil's distillation.

OJ: Sorry, alpha, is there an r-squared there? Can you say our correlation is .92? .08?

SW: It's a little bit different depending on which... Alpha's very strong, it's 9.6, 9.7, maybe even higher. Beta's a little weaker because we haven't actively worked on the beta model too much.

PH: For finished labelling it's a bit different.

SW: We've obviously focused on alpha and oil in that range of samples that we've fed in. We haven't done that for beta, so we haven't tried to give it, it hasn't been an emphasis for us.

The oil content is really good and getting better, given that it takes so long to get the reference data for oils. There's not as many samples in that model, so that's getting stronger by the day, and we've worked really really hard on moisture because that is [crosstalk].

OJ: From the conversation you can see, we are still approaching NIR as an in-house production management tool primarily, and we continue to increase the data set, increase the strength of the models, and build our reliance and...

SW: It just occurred to me then, the other thing that's comes with it, we're getting all this information on a much much more usable timeline than you would normally get, but those process samples on bales used to be a huge proportion of our solvent work through the labs. The result has been that we have gone from about 600 litres of solvent through the labs per site per year, to 60. The only solvent work we're doing now are our checks and samples and our pellets and the odd paddock or bale sample.

OJ: Which is fantastic news for a sustainability aspect [crosstalk].

Nathan, thanks for sitting tight there, mate, over to you. I appreciate it's early, hope you've got a cup of coffee there.

I can only imagine that quality is a significantly high priority at the brewery. When you're dealing with suppliers and appointing supplier partners, are there specific certifications on raw materials that suppliers need to have before they can work in effectively with you?

NC: There's probably a couple of external ones that we look for. Pete mentioned the ISO:9000 series of certification, so that's around your quality system. That's obviously really really important for us and what we look for. Secondary to that is probably your food safety or HACCP certification, which I know you also have. Probably thirdly to that, though, we also run our own approved supplier or internal audit schedule of suppliers, which you guys are accredited for.

Typically that means we'll come and spend some time with you every few years and during those audits we want to have a bit more of a deeper look around some of the other systems that you have in place on site that ensure the quality of what you're doing, things like having really strong, good manufacturing in your plant and equipment, having good pest control systems, along with a lot of other things that ultimately give us a level of comfort around the quality of what you send us on a regular basis.

OJ: In terms of quality manufacturing practices, is things like food-grade lubes in the machinery and hydraulics and things like that?

NC: Things like that right down to as you move through the plant, how do you limit human contact in the kilning area. I know that you've got quite strict rules during that process around having limited number of people come into the kilning area where contamination of your kilned hops can occur, so that's probably a classic example of where that system adds value to the end user.

OJ: Great, and a supplier assessment is, off the top of my head, a two- or three-year rolling basis for Lion to come on, so at HPA we've been supplying hops into the Toohey's/Castlemaine-Perkins/Lion Group since before HPA was HPA, right? We've been working together for a long, long time.

NC: Absolutely. Typically, we'll often try and come through every year just to have a look at the general quality of the hop and how the harvest is progressing and maintain those relationships with the team you've got there. The certification side of things is typically on a two- or three-year cycle.

OJ: The formal two- or three-year thing aside, are you able to harness the onsite visits if it's just a more industrial tourism perspective without the formality of audit? Your team members coming on farms regularly on both sites every year, does that feed into your systems? Are you able to capture those experiences?

NC: Yeah, I think there's a few elements there. It always builds our brewers' capability. I think we're pretty lucky here in Tassie that you can go and visit a hop farm by jumping in the car and driving for an hour or two. We look at our other sites all over the mainland Australia region to build capability, and to those developing brewers and their understanding of what does a hop farm look like? How does it function? What are the different constraints that might impact on a crop year and the quality of what you produce?

Often when we do bring people through, the quality expectations that we'd have of your systems are the same quality expectations that we'd have of ourselves. Often, we might come through and see something that you guys are doing really well and take that away as a learning, or we might see something that can help you and the rest of your customers.

OJ: It's a really important two-way street there as well. Frankly, we love having the really high-quality and lots of horsepower behind your audits and other customer audits because we do get quite a bit of learning out of it, so we're always open for it.

I guess the other part of the on-farm experience outside the formal audit piece, the other takeaway from on-farm experience is our conversations are about these quality elements about oil and alpha and how the growing of hops influences these things. When a brewer finally gets that story on a COA, I feel like the COA tells a story about those hops, it summarizes that key information. Are there any particular analysis you'd find yourself referring to regularly so that you can harness these hops – for whatever purpose they are – in your brewery?

NC: Absolutely. I think it probably comes down to the variety that you're using and its purpose in a brand, so if we were producing a classic Australian draught lager for example, we're adding varieties like Super Pride for its bittering characteristics. We'd be looking at that COA around what is the alpha content and how consistent is that alpha content across a crop year, for example.

But if we were making a different style of beer where we were using different varieties like your Galaxy or Ella, we would then be more interested in the oil content so we can produce a product that has a consistent level of that variety's hop aroma. There's definitely a few different things there that we look at depending on the variety's purpose in the brand.

OJ: That's fantastic, and I think it's the reason why we seek to improve performance on farm and seek to present meaningful information to brewers, and it is our alignment on production of quality hops from this team so that you guys can go and work your magic and make that consistent, high-quality product. And the COAs are an important piece, including, as Pete talked to earlier, that lot code.

PH: That's very important.

OJ: Allowing us to dovetail in with your needs and our needs and be able to help you guys make the most consistent beer you can.

We've actually taken another question, it's back to you guys. The question relates to alpha and oil loss between bale and pellet. First of all, contextualise that step, but then bring it back to how we're watching that and managing that.

PH: We do pre-harvest oil testing, we do pre-harvest alpha testing. We also test the bales, we test in the conditioning sheds, we're testing all the way through our process right through to the pellets, and we are watching the loss as it goes through the system, because there is a loss.

We try and actively reduce the handling of the hops, because every time you handle hops, they do lose alpha acid and oil, etcetera. We're constantly, right through the whole process, looking at all things like temperature, what's the temperature of the conditioning area, the temperature of the bales, so it's quite an important part of our process that we test all the way through, and we actually then report to the end of our season we look at how our losses have been, how can we improve for the next year as well.

OJ: And the monitoring, now with the introduction of NIR, the monitoring of bale is with NIR?

SW: It's the most efficient method we have by a long shot. The other one, we look at bales at the press and we also look at them when they come back in the pellet plant before that, so we're gathering data all along the way now.

PH: The other thing we're doing also is we're trying to get our product to the cool stores as quickly as possible so the time from baling to cool store, or from baling to pelleting, we're actively working hard to keep that down. We're trying to have them no more than five to six days after pressing before it either gets to the cool store or to the pellet plant.

OJ: Loss between bale and pellet is a reality. We've got a series of logistical and handling methodologies to minimise that, we are using NIR to facilitate better data and monitoring of the outcomes. In terms of judging success, we do circle back on these post-harvest in a wide-ranging review of performance, and as Pete says, we actually have metrics that we judge our own success against in relation to timeliness and the effectiveness of our logistics, and also that absolute.

We have some expectations around what good management will lead to in terms of loss in oil and alpha. We take that very seriously, obviously on two issues it's an economic proposition for us, alpha loss potentially back in those days, certainly [mic cuts out], but certainly about oil loss and bang for buck and impact in beer, because that is mission critical for us.

To reassure brewers out there that this is a reality of processing hops from in field at this much oil, or whatever metric, through to pellet, there will be some loss, but we take it seriously enough to actually measure it and judge our performance and make changes where we need to.

Guys, I'd like to wrap up on that note. A big shout out to Nathan, thank you, mate, I really appreciate your joining us today and giving us a little insight into the quality parameters that are important in the brewery and how you work with key suppliers such as ourselves, and some insight into your audit process.

To you two, thank you again. Middle of harvest, making yourselves available to assist me with having a great chat about quality, and it is a topic that is really close to our hearts here.

PH: Thanks, OJ.

OJ: A huge thank you to everyone who was part of this session. If you missed some of the action because you couldn't understand our Aussie accent, a recording will be uploaded to hops.com.au/virtual-harvest. For further information, please email info@hops.com.au, and we hope to welcome you all on farm again soon.