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**VIRTUAL  
HARVEST  
2021**

## ***Breeding Facility Tour***

**Owen Johnston:** Welcome to our hop breeding facility located at Bushy Park Estates, Tasmania. Today we're going to meet Dr. Simon Whittock, head of our Agronomic Services and leader of our hop breeding program. We're going to go behind the scenes and see what it takes to bring an experimental cultivar right through to commercialisation.

**Simon Whittock:** The beer industry's evolved in a big way and so has our hop breeding program. It began way back in the 1950s when our focus was on improving alpha acid yield. Then, the early craft beer movement rolled around in the 1980s and beer drinkers began to move away from low aromas and bitterness toward more diverse flavours, so we changed tack to give the brewers what the people wanted and began to breed uniquely Australian flavour hops.

**OJ:** Since then, our hops have moved from a bittering commodity to heroes of the modern beer world. Of course, this is no happy accident, but the outcome of a rigorous hop-breeding program that generates more cultivars of interest every year. This is where the magic starts.

G'day Simon.

The genetic diversity represented on these benches could have implications for the industry for many years to come. Is it possible there are flavours here that are not currently available to brewers?

**SW:** That's certainly something we're working towards with these seedlings here.

The process starts in January. We come to our collection of international- and Australian-developed genotypes, then we select the female plants that we want, we isolate the female flowers from the plants that we need before they're fertilised, and then once we've confirmed that the flowers that we've isolated are fertile, we add the pollen that we need.

**OJ:** How many of these crosses do you do a year?

**SW:** We deploy about 30 or 40 of these bags on each site each year. This is one that we've got here that's worked really well. Those 30-40 crosses in every annual cycle result in between 3,000-4,000 seedlings deployed into the program every year.

**OJ:** We've targeted the male and the female and successfully crossed them in the bag, does that give you insight into what you expect to happen?

**SW:** That whole process feed back and gives us information about the agronomic performance and the expected flavour outcomes when you use a particular male or a particular female.

**OJ:** We know the parent heritage, we've got a target in mind for agronomics and flavour indicators that we're looking for, what happens next?

**SW:** After harvest we come through and we collect the mature hop cones and clean the seed from those. We then stratify the seed over winter before germinating it in the greenhouse in October.

We reduce the seedling population systematically over a number of years.

**OJ:** What's the very first stage of screening?

**SW:** The very first stage of screening is on sex phenotype. We've collaborated with UTAS and Diversity Arrays Technology in Canberra to develop a molecular marker system that has the capability of differentiating female from male plants in the nursery.

**OJ:** What's the benefit of applying molecular marker technology?

**SW:** Being able to identify female plants early in the process we're able to deploy a higher quality of material into our field trials. Unfortunately, it won't decrease the amount of time it takes to produce a new cultivar in the breeding program, but it will increase the likelihood of a good outcome.

The second phase of screening is looking at the plants very closely in the field, and we want to see consistent high agronomic performance, a consistent picking window, and good yield outcomes over a number of years.

**OJ:** Does flavour come into selections at this point?

**SW:** After six or seven years of field trials, we will select from among the elite plants some plants to go into internal brewing trials.

**OJ:** And the success rate from 3000-4000 cultivars to commercialisation?

**SW:** It's much less than 1%. It's probably 1% at each step of the process.

**OJ:** It seems as though there's quite a lot of decisions to be made on farm before a brewer gets to see an experimental variety. What's a typical timeline before a sample will go to a brewery for a trial?

**SW:** We wouldn't let samples of an experimental genotype go out to a brewery inside six years, sometimes it might be eight or ten years depending on the circumstances.

**OJ:** Who do you target for trial work?

**SW:** The best brewing targets at that early stage are breweries with small-scale capability and a good sensory program.

**OJ:** Trying to link what we observe from the agronomic screening process to meaningful sensory data coming back into complement our decision making.

**SW:** That's right, just like we need to see reproducible agronomic outcomes, in our experimental trials we need to see reproducible sensory outcomes in different contexts, in different beers.

**OJ:** Can you give us an example of a recent successful commercialisation, and the time frames involved in that one?

**SW:** In 2020 we released Eclipse, which first appeared in our program as a seedling in 2004 and made its first appearance in a seasonal beer in 2012.

**OJ:** Have you got a couple examples of other highlights from the program?

**SW:** Galaxy was bred in 1994 and was released on a commercial basis in 2009, and Enigma was bred in 2002 and released as a commercial prospect in 2015.

**OJ:** That's a really fantastic result, isn't it, at quite a rate.

The collaborative nature of the beer industry is extremely helpful when we're bringing a new hop to market. We're able to work closely with brewers during the trial phase to capture valuable sensory data. This ensures that we only progress hops that can achieve agronomic success and brewer acceptance.

It's a long process from start to finish, but it's worth the wait.

G'day, thanks for taking the time to tour our breeding facility. It's the hub of our agricultural innovations and the reason we can bring choice and diversity to brewers. I'm joined by two great guys, with me is Simon, of course, and Mark Goldsmith from Asahi Beverages.

Simon's manager of our Agronomic Services and heads our hop breeding program. Journey into hop breeding began with a science background and a PhD in Quantitative Genetics.

**SW:** That's correct.

**OJ:** I don't even know what that means necessarily.

Now Simon's been with us many years, joining the HPA team in 2008, and I believe that constitutes expert-level knowledge in hop breeding by now, especially given the successful releases we've had proprietary varieties in the recent past.

**SW:** Thanks, OJ.

**OJ:** We're also joined by Mark Goldsmith, Group Senior Manager of Raw Materials Development at Asahi Beverages. Now, later on, Mark, I'm going to get you to explain what that title involves on a day-to-day basis, because that's a ripper, too.

Mark's been actively involved in brewing trials with our experimental varieties for many, many years, and Mark, you're approaching 30 years in the industry through various quite well-known operations like Matilda Bay, CUB, SAB-Miller through that period, AB-InBev and now, more recently, Asahi Beverages.

Keen interest in raw materials has seen him contribute to quality assurance, production, research and development, as well as brewery support over this long journey.

I thought this was quite interesting, Mark, and I wasn't aware of this, that your PhD was in the Mechanisms and Control of Light strike. We'll have to have a beer and talk about that at some point.

Anyway, welcome. Thank you for making yourself available and sharing your experience of agricultural innovation, and particularly your insights into hops.

**Mark Goldsmith:** Thanks, Simon and OJ. It's nice to be here and hope there's some people out there listening. Welcome the opportunity to say something about what we've done and what I've done at CUB and the various roles I've had. Thank you.

**OJ:** I'm going to take the opportunity to pepper these guys with some questions, and Simon, first one's for you. There's only a handful of hop breeding programs in the world, does ours differ in any particular way?

**SW:** Yeah, I think the main difference that we have in our program is a structural one within the business, in that we're completely vertically integrated and we own the process from plant breeding to propagation, deployment, production and marketing. Other programs around the world, there tend to be different stakeholders at different stages along the way. We can be a little more clear in our decision making, possibly have a bit more control in those areas.

**OJ:** A timeliness of an outcome and a decision to progress or not to progress is somewhat easier in this vertically integrated business?

**SW:** Provided that we are clear with our objectives within the business, yes.

**OJ:** Are you seeing any, from both our program and from other programs, are you seeing any global trends emerging in hop breeding in the recent past?

**SW:** I think the interesting ones that I've noticed recently is the push towards more efficient growing methodologies with an emphasis on sustainability. Improving yield, improving water use efficiency, nutrition, and things like that. That'll be a part of the next generation of hop breeding efforts.

**OJ:** Is the quest for higher alpha still active?

**SW:** Definitely, I think so. That's an important factor for a hop producer and for the brewing industry globally. The yield of alpha per hectare is a really critical element of the hop and beer world.

**OJ:** Does the quest for alpha influence the way we approach our current value paradigm in our breeding program?

**SW:** That's an interesting question, good one, OJ.

It is interesting in two ways. One, we need to maintain the capability to deploy high alpha hops should that be what the market requires. We need to maintain those genotypes that we know produce high-yielding, high-alpha offspring that we can assess.

The other element is that a lot of the modern, high-intensity flavour hops tend to be associated with at least moderately high levels of alpha acid. If you get the metabolite accumulator, they are associated with [crosstalk].

**OJ:** [crosstalk] currently, isn't it?

**SW:** That seems to be the case. Varieties like Galaxy and Eclipse and Vic Secret and things like that.

**OJ:** The pursuit of alpha is still relevant, as is some of those fundamental principles like overall agricultural yield. Where does the balance lie? Can you describe that? If a hop has a great aroma but an average yield, where do you draw the line and it doesn't progress in the program?

**SW:** We have a fairly definite approach to that in terms of the experimentally derived yield estimates that we see. Anything that has a flaw in that agronomic or agricultural context we increasingly eliminate as early as we possibly can in the program.

In the market context, the acreage required to develop the kilos or tonnes of hops to supply the market, once you have a very low yield the acreage just gets too big. and the costs are too high. Even if you have a brewer out there who may be ready to pay well above the odds, it just doesn't stack up once you try to scale it out to a viable production-scale use, for sure.

**OJ:** So there's that production element as well as that actual cost of goods sold perspective from the brewery, so there is a ceiling on price.

**SW:** Oh definitely. One person might be prepared to pay for a specific variety doesn't mean that it's possible to take that to market.

**OJ:** The time it takes to determine whether an experimental variety can achieve favourable agronomic and flavour outcomes is reasonably long. Is there any way to shorten this? And are you working on speeding up the process?

**SW:** I have, it might be a little out of step on this one with people around the world. From what I've seen in my experience and my time here, one of the critical factors in achieving success once you've gone to commercial deployment is the number of years that you have had that genotype to play with before it gets to commercialisation.

We only get one shot per season, so we can improve the efficiency of different steps of the process, but unless we completely change the production system, actually decreasing the time to market or between crossing and deployment to market, presents a big risk.

**OJ:** You're saying there's a really strong correlation between us knowing more and more about the performance of a hop and its likely commercial success if it gets to that point.

**SW:** I think so.

**OJ:** You need a mandatory or a minimum, you need to know. You need to have this hop in the program for a number of years.

**SW:** You need to see it at a decent scale in different environments, different soils, different irrigation contexts and to have it perform reliably.

**OJ:** I know we touched on it in the video just previously, and it's the reason Mark's joining us today, that includes and is not just about the farmer side. This is the very same principle I think applies to us getting good sensory feedback back, and the more years we've got it in the program and the more times that brewers can give us meaningful sensory feedback, the higher probability of success when we commercialise it.

**SW:** That's correct, I think so. It's a robustness test, if you like, and that just can't be achieved, all those different dimensions can't be covered in a short time period.

**OJ:** We do have a long process, how can brewers stay across what is in the program and what's in that pointy end, that elite group?

**SW:** Mark's program is a good case in point. They've stayed in touch with what we've been doing over a very long time now. We're generally happy to have sensible conversations with brewers about the six or 12 genotypes that we might have at any one time right at the top of the program. Once you go to a level below that, there's just so much material and so much information to comprehend, it'd have to be someone that was really, really keen to actually stay across it in a meaningful way.

**OJ:** Because as we communicate actively with the customer base all the time, when we're working with experimental varieties there's no guarantee that they're even going to exist next year, let alone that the commercialisation proposition. There are so many unknowns yet to resolve. There's always that caveat on trialling experimental varieties.

**SW:** And the other one, too, is we've put those showcase gardens in place where we have a row of each, I think there's five or six experimental genotypes in both Victoria and Tasmania, that are all in the one place. When we have people on farm we can take people there, you can walk across the rows, you can see the hops growing, you get a feel for their character.

**OJ:** Do you think that early exposure to the advanced experimentals helps inform brewers of flavour possibilities that could end up in beer styles?

**SW:** I would hope so. It's really interesting to hear the brewer feedback on those hops, both from the field and once they take them into beer. Hopefully we have material there that presents a new flavour opportunity for brewers. That's what we're trying to do at the moment.

**OJ:** I can definitely vouch for the fact that I've been in those showcase blocks with brewers and people, these are more creative types than me, and they can rub these hops and smell these aromas, and immediately they start envisioning the destination, what beer they're going into. Their vocabulary is just astounding, it's one of my favourite parts of having brewers on tour on the farm is that moment there in the showcase.

Talking about flavour, if you could breed a hop with any flavour, what would you choose?

**SW:** I can write my own story here because we've got one in the program now that I'm super keen on, and I don't think there's anything like it around the world. It's ginger and saffron.

**OJ:** Wow.

**SW:** Yeah. So if I can nurture that one into some sort of exposure, I think we'd see people doing something exciting.

**OJ:** I assume it's back in the program a bit?

**SW:** Yeah, a year or two away.

**OJ:** Saffron and ginger, put that in your creative juices.

**SW:** Yeah, can't wait.

**OJ:** Fantastic.

Mark, again, thanks for making time to be with us today. Personal question for you to get us started, do you get excited about trialling new hops as they come around once a year?

**MG: OJ,** I think if you talk to my wife, I get excited when I talk anything to do with beer and anything to do with my job. She says that's when my eyes light up, when I'm talking about my job and talking about beer. So that's a pretty easy "yes".

I suppose when we specifically look at trialling new hops, and I'm heavily involved in trialling new barley varieties as well, there's a key difference with hops is that we're always looking for something that's new and different. Hops have driven beer differentiation styles quite significantly in the last ten or 15 years, so that's what's really exciting and interesting and different about hops.

And new varieties, when I make the comparison to barley varieties, which I also spend a lot of time and do work with, it's also exciting to me. But the reality is I'm looking for varieties in barley that just are going to replace the ones that we have and we're not looking for something new and different, we're looking for something that's going to give us the same flavour profile.

In that respect, the evaluation of new varieties in hops is much different and therefore, in this audience, maybe more exciting, more interesting.

**OJ:** If you'd like, the criteria and the measure of success that you're applying across those two just as juxtaposition of two agricultural breeding programs, the criteria for the barley programs and screening and the criteria and measure of success for the hop screening programs are almost polar opposites.

**MG:** Yeah, that's right, completely different. The barley program we're looking for something that's going to give us exactly the same flavour profile, no processing issues, maybe some benefits, certainly, but not necessarily. It might have lower beta glucan, which gives better filtration performance. It might have higher extract, which gives us higher alcohol yields.

But the hops is the opportunity to drive new products and new flavours, and that's what's really driven the beer category, I think, in the last 15 years.

The poor old malt is falling a little bit behind, shall we say, at this point. Although lately there's been lots of interesting work being done on the flavour that you can get from malt, so maybe it'll catch up, but it's got a long way to go. The hops have really taken the lead in that regard.

**OJ:** Yeah, mate, definitely. And there are calls for that sort of flavour-driven innovation in malt, and I think the success of the hop industry, and HPA's potentially not that unique in the sense that we have shifted completely away from the traditional, the pursuit of alpha, etc., which is more akin to the barley programs and have pivoted over into flavour now. I think it's quite evident that the diversity of hop profiles out there now is really quite stunning, quite impressive.

**MG:** You mention about alpha, you look at alpha, I suppose my view on alpha is it's really just a commodity. Where the alpha comes from is less important when you're adding it purely for the bitterness in the beer. Yes, there's still a need for alpha, and you look at also the categories that are driving volume more recently, and they're beers that actually have lower bitterness. So yes, it's still important, but to me alpha is alpha, and where it comes from is less important compared to the hops that are driving flavour and aroma.

**OJ:** Fair commentary. CUB's, and I refer to CUB because that's my experience, CUB's long run hop screening program, it is actually the longest-running partnership in new cultivar screening here at HPA. How long have you been directly involved in that program through the CUB days?

**MG:** I've probably been involved for 10 years or so, and I don't know if Simon knows, but shout out to Mick Jontef if he's listening, or people that know Mick. I think Mick Jontef started the program a long, long time ago, and to be honest I'm not sure how long ago it is, but I know the program started before we even had analytical capability to check on the different varieties, so that's something that's at least been around now for ten years.

**SW:** I've got records back to 2005, Mark, maybe even 2002, 2003.

**MG:** That sounds about right. It's really Mick, he started the program and started looking at new hops. He's had a number of successes even early on with hops which were at least shortly commercialised that Mick used. Often the new varieties were used in Cascade First Harvest, so that was a series of brews that CUB or Cascade did a number of years, taking the new varieties, so once they'd gone through the screening program but then also putting into commercial beers for limited release.

**OJ:** I certainly recall, through conversation with Mick, that as you refer to "before we had analytical capability", I remember him speaking about what that engagement took, and it really was coming on farm and walking around. As Simon's described, keeping across what varieties were available and what would then be of interest to bring into CUB for further screening in beer, so to speak.

Can you give us some insights into what the process looks like now? We've already talked about what you might be looking for in terms of diversity or stand out flavours, but can you give us a little more insight into nuts and bolts?

**MG:** CUB's in a fortunate position to have a PLC-controlled pilot plant. This is small-scale, we're talking about 100 litre brew, 20-40 litre fermenters, but PLC controlled. It's the ability to control your brew and your fermentations that drive consistency in outcomes. When you're looking at screening barley varieties, or hops, or other raw materials, it's a comparative screening.

We're able to take standardised, non-hopped wort from the big plant, so our pilot plant is situated inside the Abbotsford plant, so we don't have to brew for hops, we don't have to brew each time, we can take standard wort from the big brewery, we can split that up into six or more different brews, pre-boil, add the hops, and then standard fermentation, which is well controlled with our standard yeasts.

The program initially started by adding the hops in the kettle late, so we were after the aroma profile, and to be honest way back then when it started, I think dry hopping wasn't even around. At this point, the program's still continuing to screen the hops in that methodology, if you like, by late-kettle hopping. Although it is something to think about, whether we should be then starting to screen the hops in a dry hopping method, which is very common and popular now, of course.

So we have standard, non-hopped wort, we can add the new varieties late in the kettle, re-boil them, ferment them, then go through our taste panel. We process the beers through to storage beer and then our taste panel, which has been specifically trained on identifying hop flavours. I think that's the other key that's changed in the last number of years, now it's not reliant on one or two people to give their view or their opinion on the hop, it's actually a panel. And panels, I think, are the best way to do that. They've got a panel of maybe six to eight core people that have been trained in hop, in identifying hop flavours, and panels tend to give you a better outcome than one or two individuals. One or two individuals may be worse or better in identifying particular flavours, but when you look at a panel average that gives you the best outcome.

The other thing that I mentioned earlier was, of course, the ability to analyse hop flavour. I think when we started back around 2010, it was probably quite unique and quite different. Now we've got GC Mass-Spec with solid phase microextraction. I think it was quite unique, Dr. Bob Smiley developed it at the time, and since then, of course, I think everyone working in hops has got this sort of technology, or at least access to it. I think it gives you really good specific information on the sort of compounds that are coming through into the beer, and to me that's the key thing.

While we analyse the pellets, we can do that, what's really key is what's coming through into the beer. The transformations that occur through fermentation as well – and you know this sort of stuff – but what's in the hop's not necessarily what ends up in the beer. I love to do a sniff and rub as well, and I think sniff and rub's really good at identifying or characterising a particular hop once you are familiar with it, but for new varieties – and that's what we're talking about here is screening programs – I think you've really got to assess the beer to know whether that hop's got potential in terms of how much intensity it drives in the beer, the flavours that it gets in the beer, and whether they actually like those flavours, whether those flavours are different to the hops that are already available. I know we've looked at a number of hops in more recent years and we say, "Yep, that's really good, but it's probably pretty similar to Galaxy."

From your point of view and from our point of view, is there any point in releasing another hop that's the same as Galaxy? Probably not. Unless it had specifically a very much higher yield, then it'd be another "me too" variety.

You're looking for something that's a little bit different to those hops that are already out there. Being able to put it through the beer, the sensory panel, the analytical testing, that's when you can identify those sorts of opportunities.

**OJ:** Mark is there – I completely agree with what you're saying there – in that pursuit of difference and when you do identify it by panel, which I think's a really powerful tool, do identify a hop with difference, is there a role for the smaller breweries in the Asahi Beverages network in bringing these hops to life? Once you've identified an agricultural innovation, how do you bring it to life and explore the impact in beer more thoroughly?

**MG:** That's a great point you make, OJ. I think nowadays that the group has got some craft breweries under its wing is actually going to make that much easier. If you go back through the past, I've mentioned Cascade First Harvest as a limited release was a way to put new hops out there and get some good consumer feedback.

When you're a big brewery, everything tends to be on large scale, and so you're taking a punt on whether those beers are going to be successful in the market or not. I think we've released recently Fat Yak Wild Yak have used some more recent new hop varieties, but of course they're done at a large scale.

It's a good point you make with the craft breweries, you've got that opportunity to do small batch beers and get them out to consumers to get their feedback, so ultimately our panel can have its own opinion on what is a good flavour, but ultimately, it's the consumers that decide what's successful and what's not.

**OJ:** There's a big difference between a 25 or a 50 hectare brewhouse, and even Cascade as the small brewery in the network at that time at 240 hectare, with all the scrutiny that traditional brands like Cascade come under, there's definitely some potential there.

**MG:** There's many craft breweries in our group now and with the opportunity to do things much more nimble and quick and get that consumer feedback.

**OJ:** We're talking generally about harnessing agricultural innovation, it's clearly quite tough and a long process. Can you give us a highlight from your time in the industry where you think, this is particularly important or successful in your experience?

**MG:** Agricultural innovation, I think these days, is around sustainability. Driving higher yields in particular. The best example I've got is actually in barley, and no-till farming systems in barley has really driven agricultural yields and reduced water usage. Looking at what's happening with climate change, the drier climate, the warmer climate's moving further and further south. Hops as well are a very water-intensive crop, and it's these farming practices that I think really help us in sustainability, drive down water usage while still maintaining yield.

In the video you mentioned molecular markers, it's that sort of new technology that's on the horizon that will help drive agricultural sustainability and productivity going forward.

**OJ:** Sustainability's definitely a topic that's on our mind, and we've got a full presentation and Q&A panel on sustainability later in the Virtual Harvest Program. We seek to share our current state of affairs on exactly those topics, because it does dovetail into the whole provision of choice and variety through the breeding program. We have to be sustainable in that way.

**SW:** Especially given the long timelines that we're working on. If we're not adapting the breeding program now for the climate and market context in 20 years' time, we're behind the eight ball.

**OJ:** Alright, well, I'd like to thank you both for joining me today for a chat about HPA's breeding program. Mark, thank you for sharing your personal insights and your experience. It's always great to see you, I look forward to the next time I can get into Melbourne and have a beer with you.

**MG:** I look forward to coming down to the grounds again when we get the opportunity, so thanks very much.