IMPACTS of the RosBREED project for U.S. Rosaceae breeders

By Cameron Peace

"What has been the impact?" As I stepped off the plane at Northwest Regional Airport in Fayetteville, AR on 8 July, I reflected on the last time I came to visit Dr. John Clark's Arkansas peach (and nectarine) breeding program. On a similar day in 2008, five years earlier almost to the day, I had come to see John's fruit firsthand, having met John several years earlier when he had visited Dr. Carlos Crisosto's postharvest and peach genetics program at Kearney Agricultural Center, UC Davis, where I was a post-doctoral associate enjoying Carlos' mentoring. We had been in touch ever since that California meeting, including me getting up close and personal with the DNA of some of his material by running the endoPG DNA test for fruit texture type on some of his promising selections and one distinctly unusual family. On that Arkansas trip in 2008 I was accompanied by my good mate Dr. Jim Olmstead, blueberry breeder at the University of Florida since 2009 but at the time an Area Extension Educator at WSU and co-conspirator for the first incarnation of RosBREED. On the flight over, we came up with the project's short name, "RosBREED". For this planned project to truly have impact, we believed that breeding must be the crux.

"We need you to be part of this, John!" implored Jim and I as we gathered on the first night of our visit in July 2008 over pizza and beers. What became known as demonstration breeders were the nucleus of our plan. Recruiting John was critical. Back in Washington we were on the verge of delivering routine MAB to WSU's apple and sweet cherry breeding programs. There we had a critical mass of university resources and expertise (which included the breeders Nnadozie Oraguzie joining in May 2008 and Kate Evans in October 2008) and local industry support. The probable successes in enabling these two WSU programs made them obvious RosBREED inclusions. But John's protests about his lack of experience or expertise in MAB were our exact arguments for his inclusion. If MAB could be integrated into John's modest-sized traditional program, it could be done in any. And besides this bigger-picture consideration, John's participation was expected to lead to benefits flowing into the Arkansas peach breeding program.

"What unusual combinations!" was my reaction in 2008 to an Arkansas progeny of typical size (n=49) segregating for just about every Mendelian peach fruit trait known to man: yellow/white, peach/nectarine, low/normal acid, and round/flat shape, as well as the intriguing observation of slow-melting in the fruit of some seedlings. While I'd seen peach families with more diverse parents and DNA profiles because they were introgression lines seeking to incorporate alleles from other species, this Arkansas family was one from which new cultivars might directly arise. John's approach to peach breeding was encapsulated in this family where mixing alleles in all possible combinations might just lead to some exciting new fruit types for new markets. This family became the cornerstone of the contribution from John's program to RosBREED's peach germplasm set.

Fig 1. *Very sweet* fruit selection from John Clark's University of Arkansas breeding program.

"Delicious!" Sampling (alright, gorging on) fruit from selections in John's breeding orchard in 2008 was a real treat – the kind of treat that every fruit consumer should experience every time they eat rosaceous and other specialty crop products. To my palate, the low-acid and exceptionally sweet delicacies offered up by several selections were the standouts. Evidently, the bees agreed (Figure 1). *Very sweet* – with that breeding-addressable fruit quality attribute in particular, I think fruit has a viable chance to increase its contribution to the healthy diets of our children. I applaud the strategic efforts of breeders like Mike Malone (Plant and Food Research [PFR], New Zealand, retiring) and Dave Byrne (Texas A&M and RosBREED demonstration breeder) in targeting the development of super-sweet peaches (SSC of well over 20 °Brix) and the dedication of breeding-support geneticists such as Emily Buck (PFR, New Zealand) and Yingzhu Guan (WSU, RosBREED apple breeding trainee) for tackling the recalcitrant trait of "sweetness". The U.S. breeding-production-marketing-consumption continuum allocates high socio-economic value to sweetness, and although at least a certain level of sweetness is ubiquitously targeted by peach breeders, its typically low heritability means that traditional selection only vaguely achieves target levels. This genetic aspect of sweetness is the very thing that would mean high impact for the breeding use of DNA information on it. The texture of some of John's selections was also memorable – smooth, buttery, surrendering sweet juice to each bite only as desired. My teeth felt like they were easing into a bed of silk sheets. I took home a tray of my favorites and one particular non-melting nectarine selection softened gradually to give my mouth a melting-like caress even after two weeks at room temperature – an excellent trait for the end-consumer! In 2013, John has released that selection as 'Bowden' (Figure 2).

Fig 2. 'Bowden' nectarine. Photo credit University of Arkansas.

"You could transfer the MAB approaches to your other fruit breeding programs," Jim and I suggested to John, seeking to close the deal in 2008. Transferability of scientific advances among and beyond Rosaceae crops has long

been a hallmark of genomics and genetics of this model plant family. The shared ancestry provides opportunities to transfer DNA information directly, such as the genomic region controlling fruit skin and flesh redness. The large industries and research funding support for these most economically important and diverse temperate crops makes them the most advanced in scientific understanding among perennial fruit crops. While it would be John's peach program under the RosBREED umbrella, his blackberry and grape breeding programs also stood to gain, beneficiaries of the "demonstration" concept. Coincidentally, I met JD Swanson, Rubus geneticist and in 2014 the Chair of RosEXEC, on this same 2008 trip, among John's seedling rows. JD is helping ensure RosBREED's advances are indeed being transferred to other Rosaceae crops.

"Y'all convinced me. I'm in! But I'll need help," John agreed, as we shook hands and wrapped up the 2008 visit, me with tray of peaches under arm. I assured John I'd stick with him and not only because of the sticky peach juice all over my outstretched hand. On the flight out, Jim and I devised RosBREED's byline. "Enabling" means we are not just touting the promise but providing the instructions for implementation (as mentioned in this column in May 2011), and one of the critical elements has proven to be provision of MAB expertise for individual programs. RosBREED's 12 demonstration breeding programs have received this support over the last few years in group settings as well as on individual bases to address program idiosyncrasies and facilitate MAB capability and execution. RosBREED's future impact will surely depend on how well such support is provided to any and all breeding programs.

"I don't have the time to figure it all out myself." RosBREED's approach has always been to integrate new DNA tools and knowledge into ongoing breeding operations, not to distract breeders detrimentally from what they already must do and do well. One solution is to train the next generation of fruit breeders and allied scientists in the skills, experiences, knowledge, and specialties required for the new millennium (tip of the hat to Fred Bliss). RosBREED provided direct support to demonstration breeding programs in the form of graduate student assistantships – which supported breeding trainees (as the project called them) or RosBREEDlings (as they called themselves). Many programs, like John's, have leveraged that support by taking on further students to also join RosBREED. Or in the case of Tom Davis (University of New Hampshire, strawberry demonstration breeder), by completely funding their student and enjoying full participation in project activities and opportunities. The first Arkansas breeding trainee was Masters student Paul Sandefur, who graduated in December 2011. Paul then continued on perfecting peaches in Arkansas, working for John through 2012. There he implemented some ideas he'd developed in his thesis project, and gained further experience with blackberry and grape breeding. Paul has now begun his PhD studies with me at WSU from January 2013, where he'll get familiar with even more fruit breeding programs and of course with the crucial translation–to-practice of DNA information. In 2012, new PhD student Alejandra Salgado joined John's program, solidifying the connection with blackberry. Then came Terrence Frett, graduating with a Masters in 2012 as breeding trainee with Ksenija Gasic (Clemson University, peach demonstration breeder), now another PhD student of John's who's helping to bring new MAB knowledge and tools to application. All three are great examples of smart, enthusiastic, hard-working, and solution-minded soon-to-be professional breeders or breeding-support allied scientists who learned about both traditional and DNA-informed approaches under the RosBREED umbrella. In fact, I think that training of the next generation of fruit breeders will be RosBREED's most far-reaching impact.

Fast forward five years and I've again thoroughly enjoyed the fruits of John's continued innovative labors. What has changed for the Arkansas peach breeding program since John committed a portion of his time and joined the RosBREED family? I asked John straight out, "What has been the impact?"

"RosBREED provided me the incentive and pathway for doing marker-assisted breeding," says John. Being a demonstration breeder provided the activation energy to begin, to start along the path, and continued involvement showed him where to walk. RosBREED allowed John to come into close contact with knowledge and procedures for incorporating DNA information in breeding decisions. A key part, adds John, was the role of the breeding trainees – given that John himself didn't have the time to do all that needed to be done. And he took on the students in the first place because of the RosBREED participation – the project gave the connection to the DNA world that John believes "new students need these days."

Beyond his own program, John considers the positive impact that his program's involvement in RosBREED and conducting of MAB has had on his Department – expanding its scope, influencing new hires, and attracting more students. For his peach breeding efforts, John states that the DNA information is "throwing the curtain back" on his germplasm. For most selections he feels he knows about their genetic potential as new cultivar candidates or as new parents. "But I don't know them all, and I don't know future ones."

A cadre of current and future breeding professionals have been informed and equipped. Paths have been blazed and trodden. Jewels have been found and polished. More and more of RosBREED's deliverables will undoubtedly convert to impact for Rosaceae crop breeding and beyond. Of course, this is not the end of the MAB story – most of RosBREED's participants will continue to carry the torch and deliver positive change, and we hope and expect you community breeders will continue to benefit.

It's astounding how far we've come, and the future looks bright. But for now, John Clark revels in the present. **"My inspiration is as high as it's ever been. I've hit my peak – but it's a high mountain. I think I'll sit here a while."**