

Plant Breeding Matters

Information from the British Society of Plant Breeders

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James Wong addresses BSPB on the nuances of science communication

“In stark contrast to how some would portray the modern food system, we have never had access to a more plentiful, more affordable, more nutritious and safer food supply than in the history of our species. So why do so many people think the exact opposite?”

That was the dilemma posed by science writer and TV presenter James Wong when he addressed the BSPB Annual General Meeting.

A botanist by training, Wong contended that access to healthy food has dramatically increased as a result of improved agricultural practices and innovation.

Wong challenged the notion that modern food is less nutritious than it was in the past, or that higher yields and hi-tech farming methods have somehow diluted the beneficial minerals and nutrients in our staple food crops.

In seeking to validate the scientific evidence behind this issue, a major stumbling block is sourcing like-for-like data sets, some stretching back to the 1930s, he said. Simple testing criteria,

such as whether or not soil has been washed off samples, or differences in cooking times, can make such comparisons misleading. For example, nowadays broccoli is cooked for just 5-10 minutes, whereas in the 1930s it was routinely boiled for 45 minutes or more.

Compositional studies have also shown that seasonal effects can have a much greater effect on available nutrients than varietal differences. Wong highlighted a US study of broccoli – an excellent source of magnesium, potassium and calcium – which compared 46 different varieties in the same field. While some larger-headed varieties did show

a slight decline in available potassium and magnesium, the year-on-year differences caused by the weather and growing conditions were twice as great as any difference between varieties.

Even the UV lights in supermarket shelves have been shown to affect folate and vitamin levels in fresh spinach, highlighting the challenge of comparing like with like on this issue, he added.

And although it is often argued that locally-grown or seasonal food is better for you, there is a strong case to believe exactly the opposite, he suggested, since our ability to break out of seasonal restrictions by importing food from around the world has helped overcome nutrient deficiencies at particular times of year.

Locally-produced food is also portrayed as better for the environment in terms of climate change,

but again this is not supported by the facts, he said, since just 6% of the carbon emissions in our food supply come from transport.

In such a complex, value-laden area in which the scientific evidence frequently runs counter to popular ideas and intuition, Wong suggested that a major challenge for the plant science community is to understand why people are predisposed to see foods from the past as healthier.

A strong evolutionary driver for this is that humans have learned which wild plants are toxic or not through storytelling, passed down from one

generation to the next, not from lists of facts and figures. Wong suggested that this might explain why we trust what our grandparents tell us

is safe, and why people are instinctively sceptical about new things.

In today's post-factual world, Wong urged the entire plant science community – including plant breeders – to resist the urge to stand behind traditional methods of science communication, to get better at storytelling and to engage with social media and other online methods of communication.

“Social media is cheap and quick to do. It reaches so many people, and because it is not filtered through the traditional media, it works in the same way for good or bad. We need more scientifically literate people on social media because the bubble of ‘wanting attention’ and the bubble of ‘thoughtful analytical’ are very, very different people,” he said.

‘Although it is often argued that locally-grown or seasonal food is better for you, there is a strong case to believe exactly the opposite’



Breeding for life without neonics

After the EU extended its ban on using three neonicotinoid insecticides to cereals and sugar beet with effect from December 2018, this spring will be the first time in 25 years that UK growers have planted crops without the protection of these widely used seed treatments.

Farming unions have accused the EU of being overly cautious, warning that the ban could hit crop yields hard with no measurable benefit to bee populations. In sugar beet, for example, where neonic seed treatments have routinely been

used on 99% of the crop, the British Beet Research Organisation (BBRO) has warned of potential yield losses of more than 40%, costing the industry £50 million in high risk years.

This may explain why, in the wake

of the ban, many EU member states moved immediately to approve temporary derogations to permit the continued use of neonics.

However, no such respite has (yet) been granted to UK producers, who must devise alternative strategies to cope with the threat of aphid-transmitted diseases such as virus yellows in sugar beet and barley yellow dwarf virus (BYDV) in barley.

There is a general agreement that an integrated approach is needed, combining varietal selection, seed health, agronomy, field monitoring and foliar sprays.

But with a rapidly depleting armoury of crop protection products available, much attention is also focused on plant breeders' ability to provide durable genetic solutions to combat the loss of neonics, through the development of resistant varieties.

Here, two BSPB member companies describe the breeding response in sugar beet and barley to counter the impact of the neonic ban.

Rhopalosiphum padi, bird cherry oat aphid transmitter of BYDV



Rothamsted Research Ltd

Ian Munnery, General Manager UK, SESVANDERHAVE

Although beet was later than many crops to see the removal of neonicotinoid seed treatments, this has certainly caught up with UK beet growers this year, with high levels of virus yellows forecast for 2019 after a mild winter and warm February boosted aphid populations.

Neonic seed treatments have been universally used by sugar beet and fodder beet growers to protect against aphids carrying virus yellows since they were introduced in 1994. The UK is exposed to a greater extent than continental growers due to our mild maritime climate which can allow aphid populations to thrive over the winter months.

The UK's decision to implement the EU ban left many in shock. The timing couldn't have been worse; low sugar prices and a shortage of animal feed after the 2018 drought has led many to question the crop's viability. To rub salt in the wound, immediately following the EU-wide ban many other member states approved derogations permitting continued use of neonics to protect their domestic sugar beet industries.

For beet breeders this situation

presents an opportunity, and has prompted many to ask when will we will be able to come up with a genetic solution.

The challenge is two-fold. First to maintain a viable sugar beet industry in the short-term to fund the breeding work via seed sales, and second to breed for such a complex dual target of aphid and virus.

Breeding a variety takes around ten years and seed

production around three. Ironically the impending ban sent many breeders to dust off the files from 30 years ago to revive the virus yellows programmes already in development before the introduction of neonics rendered them redundant.

For SESVANDERHAVE, identifying and developing genetic traits which offer tolerance or resistance to virus yellows has long been a key breeding target.

The risk of reliance on a single product such as neonicotinoids was



clear early on, particularly since virus yellows can knock 40-45% off a crop's yield.

Our company has invested in extensive research to further this aim over the past decade with a number of universities and institutes. One such project, started in 2014, involves the development of a novel pre-breeding strategy to identify genetic sources of resistance.

A collaboration between BBRO, SESVANDERHAVE, MariboHilleshög and ADAS, and part-funded by Innovate UK, it is still too early to say when material from this programme will be commercially available, but the interim results look promising and were presented to the wider beet industry at the International Sugar

Beet Research organisation seminar held in Belgium in March. Further field trials will be conducted this year to evaluate which of the genes identified offer the best prospects of either tolerance or resistance to the disease.

But common sense tells us that we need an integrated approach. Plant genetics is key, but factors such as early sowing and seed priming to reach full plant maturity as soon as possible, field monitoring for pests and predators, field hygiene, foliar sprays and adapting harvest dates to cope with secondary viral infections are all integral to coping with life without neonics. Nature shows us that over-reliance on a single strategy will ultimately lead to resistance.



MariboHilleshög, Sugar Beet crop

On-going screening for virus yellows tolerance at MariboHilleshög Research AB in Sweden

David Harrap, Barley Breeder, KWS UK Ltd



The writing has been on the wall for neonics for some time, and KWS along with many other commercial plant breeders have been looking into genetic means of controlling insects and their associated viruses across a variety of crops.

The cupboard is not exactly brimming with genetic sources of resistance to these threats but there is a bright spot in barley where there are a few potential solutions.

The situation with insect transmitted viruses is complex. The main problem in Europe is the aphid transmitted virus, barley yellow dwarf virus (BYDV) for which there are several different strains.

There are also other less common viruses that cause yellowing identical to BYDV – these are wheat dwarf virus

(WDV) and cereal yellow dwarf virus (CYDV).

The BYDV problem was first identified in the 1950s, and when scientists screened material in gene banks they found several lines amongst Ethiopian spring barley land race collections with high levels of tolerance or resistance to BYDV.

Further work showed that all these lines have the same yd2 gene which confers tolerance to the main strains of BYDV present in Europe, but has no effect on the other viruses.

Several new varieties were then developed from these lines, the most well-known being the winter barley 'Vixen', bred in the 1980s in the UK.

More lab work followed and it became clear that this gene conferred true genetic tolerance to the BYDV viruses. A variety with the yd2 gene could have just the same high number of virus particles in its sap as a susceptible one, but did not exhibit any of the usual symptoms, the crippling leaf yellowing or tiller death that normally accompanies BYDV infection.

Quite how this tolerance works within the plant is still not entirely understood and work is ongoing to try to find out.

KWS will have seed of a winter barley 6 row feed variety called 'Amistar' for sale later this year that has the yd2 gene. This variety was bred in France and performs well in UK conditions. When infected with

BYDV the only visible symptom is some slight leaf tip yellowing, otherwise the plant grows and yields normally. Trials in France and the UK show that even under high disease pressure, the yield loss is between 0 and 5%, compared with up to 19% in susceptible varieties.

We are fortunate that there are now good genetic markers available that make the selection of these traits much easier. Markers can also be used to select varieties that have more than one resistance or tolerance gene, conferring more durable resistance. This is a long-term goal and would be impossible using just inoculation and field testing.

In summary, plant breeders are working hard to identify genetic solutions to the loss of neonics. In some crops this will be very difficult using only conventional breeding methods as there appear to be few sources of natural tolerance or resistance. We are fortunate with barley that several economically important genes have been identified and are being worked on by most breeders.



BYDV tolerant (left) and susceptible (right)

KWS UK Ltd

Farmer Viewpoint: Jamie Greaves

Oxfordshire farmer Jamie Greaves is a participant in the 2018-19 Cereals Development Programme (CDP), a joint initiative between the NFU and Openfield which aims to identify the next generation of industry leaders in the arable sector, supporting their professional development and giving them the opportunity to experience first-hand how the supply chain and wider arable industry operate. Last December, Jamie joined other CDP participants on a visit to plant breeding company KWS. Here are his reflections on the day.

“Our visit to KWS’ offices just south of Cambridge started with a brief presentation on the company and its background. KWS is a \$1.3 billion company, with its majority shareholding still held and owned by the original families that started the company 160 years ago. KWS has breeding and distribution activities in over 70 countries, breeding seed for sugar beet and fodder beet, corn, cereals, oil and protein plants, sorghum and catch crops.

It was clear how seriously committed KWS are to driving research and development. A couple of interesting facts that really backed this up for me were that 17% of net sales go back into R&D and 1,900 of the company’s 4,950 employees are involved in R&D, proving a dedication to developing future varieties that will hopefully thrive in our farming systems moving forward.

Turning to the technicalities of plant breeding, KWS product development manager John Miles started by giving us a nice, simple analogy of plant breeding, comparing it to dolls “Barbie and Ken”, which simply means selecting the best traits from both parents to form the best offspring.

From this basic example, we moved on to plant DNA and wheat genetics, and learnt about the astonishing complexity of wheat genomes. To put this into context the human genome contains just under 3 million base pairs compared to the wheat plant’s genome which contains just under 16 million base pairs, with base pairs coding for individual traits.

This explains why wheat is such a complex plant to selectively breed for the traits that appeal to growers such as yield potential and stability, disease resistance and quality. All of these are extremely important to us now and looking ahead, with increasing pressure on agricultural chemicals, they could become more important than ever.

We then explored the different methods of breeding a wheat variety, and the length of time it takes from initial cross to marketable seed. In short,

there are three methods of breeding; the pedigree system which takes eight years, single seed descent (seven years), and double haploid (six years).

The pedigree system is the most widely used method, costing around £1 million per variety over the 8-year breeding period. Each year, KWS will typically enter 16 varieties for National List trials, with only two making it on to the list following the second year of NL trials.

The popular variety Santiago, for example, was conceived in 2004 to finally gain recommendation in 2011, demonstrating how plant breeders have to think and work so far in advance. However, with the aid of technology which is evolving so rapidly, I am sure in the future we will see these breeding method timelines shortened even more.

After an enjoyable lunch we headed up the road to the KWS Farm site, a 180 ha farm made up of trials, breeding crops and multiplication crops. We toured the impressive seed processing plant then headed to the glasshouses to look at the growing crops and to play with some wheat plants. These were just pre-flowering and we got the chance to attempt the delicate process of emasculation, which is the first stage of crossing a wheat plant. It involves

taking the male pollinating parts out of the wheat ear with tweezers, leaving the ear as all female and preventing the plant from self-pollinating. After three days it becomes receptive to pollen which is introduced from another ear with male pollinating parts. This male ear will be of a different variety and when introduced and cross-pollinated they will make the first cross.

I must say I can’t see my attempt being too successful, as it wasn’t looking in the best of states by the time I had finished!

It was a fascinating visit, which gave us a real insight into plant breeding at KWS and left me feeling very satisfied with how the UK’s royalties system is helping drive the future development of varieties that will be ever more important to our future as growers going forward.”

‘Wheat is such a complex plant to selectively breed for the traits that appeal to growers such as yield potential and stability, disease resistance and quality’



BSPB co-funds new genetic gain study

BSPB and NERC are jointly funding a three-year PhD studentship at NIAB and the University of East Anglia to update and extend a previous analysis of the contribution of plant breeding to yield increase in our major arable crops. This new study will cover more crop species, and for the first time will include an assessment of the impact of weather effects on yield gain.

Ten years ago, a major independent study commissioned by BSPB found that around 90% of the increase in national average cereal yields between 1982 and 2007 could be attributed to the contribution of new varieties.

Led by researchers at NIAB, statistical analysis of national trials data stretching back 60 years concluded that while UK cereal yield gains prior to the early 1980s were down to a combination of factors, including plant breeding, machinery, pesticides and fertiliser inputs, yield increases in winter wheat, spring barley and winter barley in the 25 years studied post-1982 were almost exclusively due to improved varieties.

% YIELD INCREASE DUE TO NEW VARIETIES – 1982-2007	
WINTER WHEAT	93%
SPRING BARLEY	87%
WINTER BARLEY	92%

The new PhD project, awarded last year to Joanna Raymond (pictured), will update the original analysis of National List and Recommended List data for wheat and barley, and will include winter oilseed rape, sugar beet and forage maize.

The project will also bring together relevant scientific expertise from NIAB and UEA to assess the relative effects of climate variability and varietal selection on UK crop yields.

This variability in localised weather and its potential impact on varietal performance is highlighted in the graph below, which plots annual changes in daily soil temperature at a single site in Wattisham, Suffolk since 1991. This reveals a difference of as much as 15°C between the highest and lowest temperatures recorded at the same time of year, with potentially significant implications for factors such as varietal selection, sowing dates, germination and crop development.

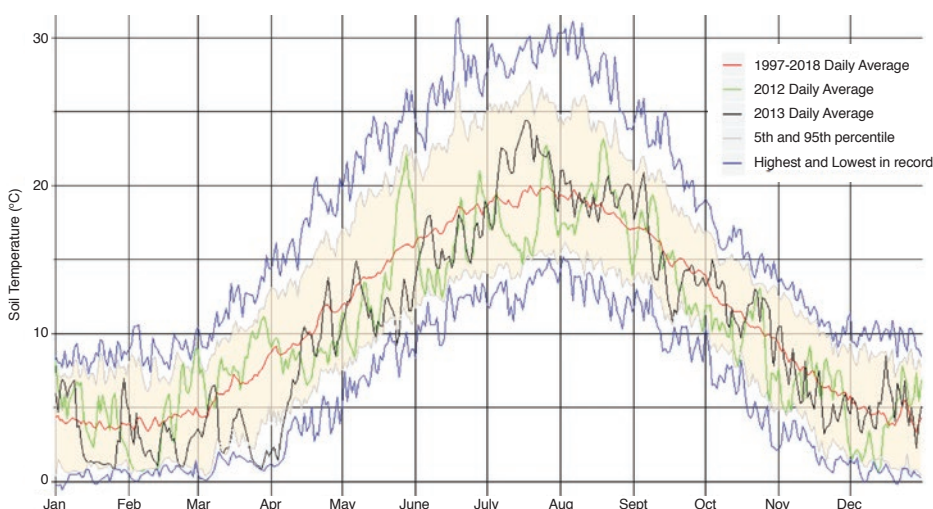
Given the apparent increase in more extreme weather events and climatic variability, extending the research to include the impact of weather effects on varietal performance could be of

significant value to the agricultural sector to mitigate against losses and optimise yield potential, as Joanna explains:

“Historical variety trial series combined with local weather records represent a powerful, multi-environment data source which can be used to generate and test hypotheses about the impact of local weather effects on varietal performance, and to better understand the causes of variety x environment interactions. This work can highlight novel breeding targets and lead to improved crop modelling and better interpretation of NL and RL trials data for growers.”



Variation in soil temperature at 10cm depth for Wattisham station since 1991



Meet the BSPB Team – Matthew Brumby

Matthew Brumby joined BSPB as Accounts Assistant just over four and a half years ago.

With experience of working in finance-related positions in companies-related to agriculture, his role at BSPB involves processing all the incoming and outgoing payments for the Society.

“Becoming involved in credit control is a change from my previous roles, which were mainly in purchase ledger departments”, explains Matthew. “Now I am making the calls instead of receiving them.”

Matthew comes from a local farming family and believes this helps in his current role.

“I think my background has helped when dealing with farmers because I understand that at times there can be financial constraints. The key is communication and I hope farmers will find all members of the BSPB team helpful and approachable.”

Having visited plant breeding sites in the UK and seen the amount of work taking place to research and release new varieties, Matthew also understands the importance of ensuring that all farm-saved seed payments are declared and settled. “The investment into plant breeding is

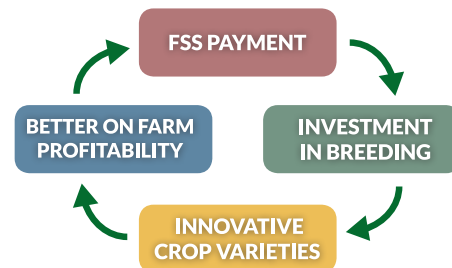
overwhelming,” he says.

Away from BSPB, Matthew is a keen football fan. He is a lifelong supporter of Manchester United, and is particularly enjoying their recent turn-around in form with Ole Gunnar Solskjaer in charge.



FAIR PLAY **UPDATE**

ON FARM-SAVED SEED www.fairplay.org.uk



BSPB presents to CDP meeting

As part of the FAIR PLAY campaign to ensure farmers are aware of their legal obligations on farm-saved seed use and recognise the benefits of supporting investment in UK plant breeding, BSPB is offering to provide speakers at farming conferences, seminars and farmer discussion groups.

BSPB's Farm-Saved Seed Officer Olivia Herdman recently gave a talk in London to members of the Cereals Development Programme (CDP), a joint initiative supported by NFU and Openfield which aims to identify and mentor the future movers and shakers in the arable industry.

Her presentation focused on the UK farm-saved seed collection system, including the legal basis, how it works and

its role in supporting farmers' access to improved crop varieties. The meeting also provided an opportunity to highlight and discuss some frequently asked questions on farm-saved seed use.

"Supported jointly by plant breeders and the farming unions, the FAIR PLAY campaign has come a long way in ensuring all farmers using farm-saved seed contribute fairly for the benefits of plant breeding

innovation," says Olivia. "But there is still work to do to deliver 100% compliance on payments, and it is clear from discussion at this meeting that not everyone is clear about all aspects of the FSS system."

If you are organising an event and would like to include a BSPB presentation on FAIR PLAY and its role in promoting investment in plant breeding for the UK, please contact Olivia Herdman.

Defra clarifies FSS requirements

Defra recently issued an update to its official guidance on farm-saved seed to provide clarification that even when crops are not taken to harvest, farmers must declare and pay for all eligible varieties of farm saved seed (FSS) they use to BSPB.

Previous wording in the guidance had not been explicit on this point and some farmers had interpreted it to mean that if seed was used for cover crops or other crops not being taken to harvest, then FSS rules did not apply.

"The use of cover crops among arable

farmers seems to be on the increase as research has demonstrated the rotational benefits for soil health, reduced nutrient losses, and improved weed and disease management," notes BSPB chief executive Dr Penny Maplestone.

"BSPB has received a number of FSS

queries from individual farmers in relation to their use of combinable crops such as peas, oats and barley in cover crop mixtures. The rules are clear: using farm-saved seed of eligible varieties as cover crops is subject to the same requirements to declare and pay as harvested crops."

FSS: why we need to contact you

Some growers have asked BSPB why they continue to receive FSS declaration forms twice a year when they only ever use certified seed or have already made their FSS payment via a processor.

We do appreciate that nobody likes unwanted paperwork, and we have tried hard to make the return process as quick and simple as possible with options to declare on paper, by email, by telephone and online.

But to ensure a level playing field for all farmers, and to optimise investment in future plant breeding programmes, it is essential that we contact all farmers

equally who have had the opportunity to use farm-saved seed in each sowing season.

It is our experience that some farmers may farm-save in some seasons and not others, sometimes use a processor, sometimes not and sometimes a mixture of the two, and we anticipate that this may change for many as the UK leaves the EU and the CAP.

BSPB collects FSS payments under

the terms of a legal agreement with the UK farming unions, and does so with their full support. BSPB greatly values the co-operation received from across the farming community, supporting investment in plant breeding through purchases of certified seed and payments on farm-saved seed use, recognising the mutual benefit this brings to both breeding and farming businesses.



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