



The challenges of breeding the best varieties for Regenerative Agriculture

Dr Phil Howell, NIAB

What to expect this session

- Phil Howell, NIAB
 - Mainstream breeding, trials and seed marketing
 - Why this may not deliver for Regen Ag
 - Steps in the right direction, and thoughts about the future
- Stephanie Swarbreck, NIAB
 - Nitrogen responsiveness as a trait for sustainable agriculture
- Ambrogio Costanza, ORC
- Questions from the floor and discussion with all speakers



Working back from mainstream markets

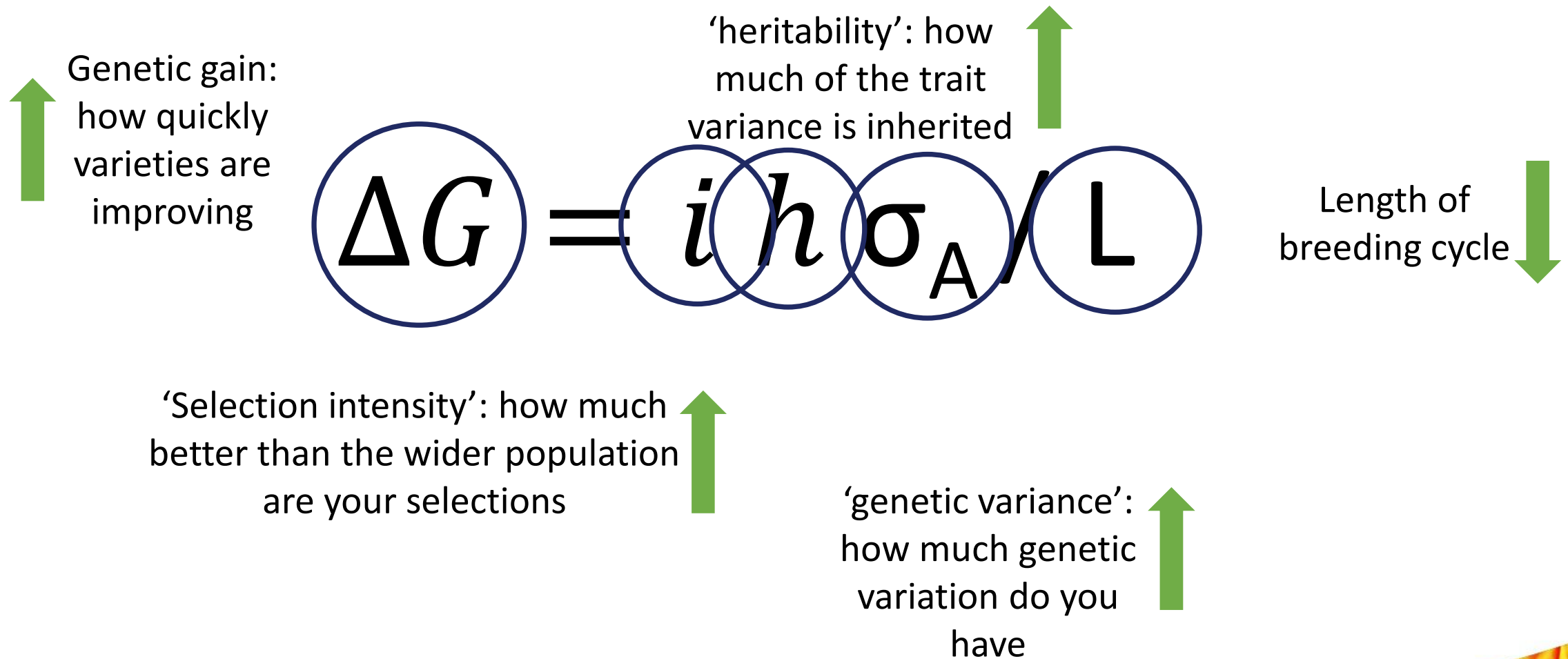
- Commercial breeding obviously targets varieties to suit the marketplace
- Seed royalty market is relatively small and very competitive
- Targeting niches is high risk - most of the certified area is sown with AHDB RL varieties
- RL criteria therefore shape selection strategies further back in breeding programmes
- If these changed, breeders would adapt and so variety type would change
 - “In principle, the husbandry of the trial should be appropriate to achieve highest quality and yield”
 - “Nitrogen applications should be tailored to give maximum yield within the constraints of obtaining the appropriate grain protein contents for intended use” [AHDB RL protocol]
- Testing in alternative situations (e.g. low-input / direct-drilled / organic trials) often deferred until near to commercial launch, i.e. at end of selection funnel
- Organic growers often favour older varieties, as selected under pre-pesticide inputs



Mainstream breeding

- ‘Cross the best with the best and select the best’
- Marker-assisted technologies help with cross design and with early-generation selection
- Accelerated breeding (single-seed descent, doubled-haploids, shuttle breeding) can also help with early generation selection and multiplication
- Field testing often starts with untreated, inoculated nurseries: selection for disease resistance, plant type, yield components
- Yield / agronomic / predictive quality testing come later
- Selection funnel – fewer lines tested at each stage, but more widely / thoroughly
- Best lines from a programme enter NL testing, best NL lines across programmes enter RL testing:
 - Each breeder 500-1000 crosses → 1-2 million F2 individuals → 5-10 NL1 → 1-2 RLT → 1 successful variety

Breeders' Equation: increasing genetic gain



Technical limitations

- Large diverse populations screened in accurate, uniform field experiments give best gains
- Regen situations do not always make this easy
- Hard to establish min-till trials and nurseries, so selecting on fundamentally different soils
 - Trials and nursery plots are best drilled into fine tilth (often ploughed and harrowed)
 - Min-till farm drills rely on size & speed, not compatible with drilling small plots
 - Opportunity for engineering solution?
- Reducing inputs is relatively straightforward, but makes trials fundamentally less accurate
 - Soil fertility, weed burden, pest impact likely to be more variable across low-input plots, needing more replication / more locations / smarter trial design
 - If more location/years required to build a robust data set, variety development will slow
- How to select for performance in blends or intercropping?
- How to best integrate with cover crops / undersowing / living mulches / overwinter grazing?

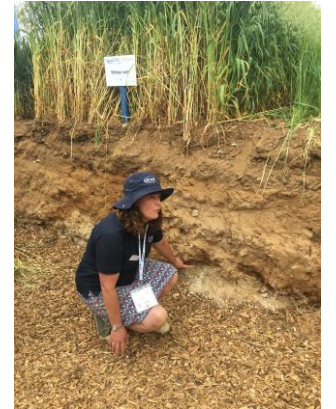
Commercial limitations

- Slower variety development might lead to increased seed prices
- Reduced inputs → reduced yield from seed crops → increased seed prices
- If RL selection criteria change, ‘burn-in’ period needed for new traits to filter through
- Or do we need separate “conventional” and “regen” lists? How will this be paid for?
- Would current high certification standards and royalty-based business model need to change?
- Variety blends and populations promise to help risk management and yield stability, but how do they fit with current royalty models?
- Will end-users (and ultimately, consumers) accept potentially lower-spec crops grown under reduced inputs?



Steps in the right direction: research

- The public sector is funding more crop research than 20-30 years ago
- Most of this is targeting the fundamentals of how to reduce inputs
- Much more known about aspects of soil health, roots, microbiome
- DEFRA have an increased research profile, much closer to policy, with several relevant opportunities

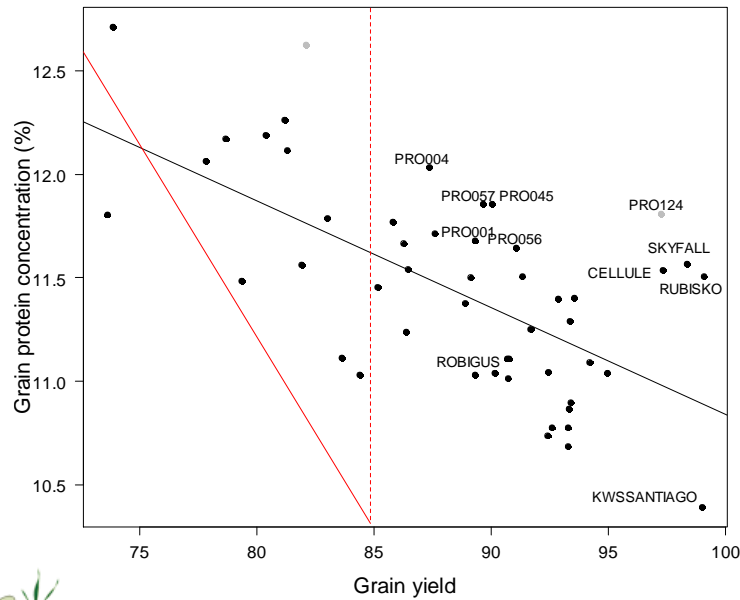


Steps in the right direction: research

- “Pre-breeding” research – moving from trait discovery in the lab to providing commercial breeders with well-adapted material
- Several BBSRC-funded multi-partner projects since 2010
- Stakeholder involvement, though largely just breeders
- Pest & disease resistance, sustainable yield improvement, improved nutrition
- Now trickling through in breeders’ own improved germplasm
- Similar initiatives needed in other crops – other cereals and grains, grain legumes, oilseeds, forage and fibre crops
- More support needed for long term experiments and studies



Steps in the right direction: NIAB research



Steps in the right direction: AHDB response

- Since 2015, RL has raised emphasis on disease resistance relative to treated yield
 - OSR light leaf spot High → Very high
 - Winter barley mildew Medium → High
 - Winter wheat YR Medium → High; mildew Medium → High
- ‘Special’ RL categories to promote rapid uptake of specialist traits
 - First seen with wheat OWBM resistance
 - More recently, OSR TuYV resistance and Clearfield traits
 - Wheat BYDV resistance, winter barley BYDV tolerance
- Wheat Yellow Rust ‘watch list’ for varieties at higher risk of ratings falling
- Variety blends tool to help growers select suitable varieties to blend
- Evaluating trials to investigate interactions between variety & primary cultivations
- Enhanced digital access to the RL to help farmers access and understand the list, RL App, Variety selection tools



Steps in the right direction: commercial work

- Breeders are actively using pre-breeding material
- Seed companies are tailoring their offers
 - Blends, cover crops, companion crops, specialist crops
- There is no shortage of companies offering biostimulants etc
- Lots of kit and advice is available
- Current prices and costs are making everyone look more closely at their crop inputs (and outputs)

Groundswell

