Diversity of sheep in the UK – do we have a problem or an opportunity?

Dr Joanne Conington

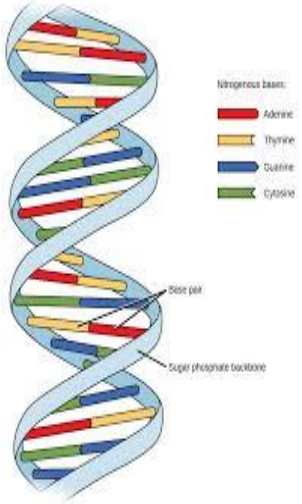
Scotland's Rural College (SRUC) Edinburgh, Scotland, UK

International Congress on the Breeding of Sheep and Goats, Bonn, Germany 15 October 2020

Leading the way in Agriculture and Rural Research, Education and Consulting

My talk

- UK sheep industry structure & phenotypic diversity
- Genetic diversity
- Genomic diversity

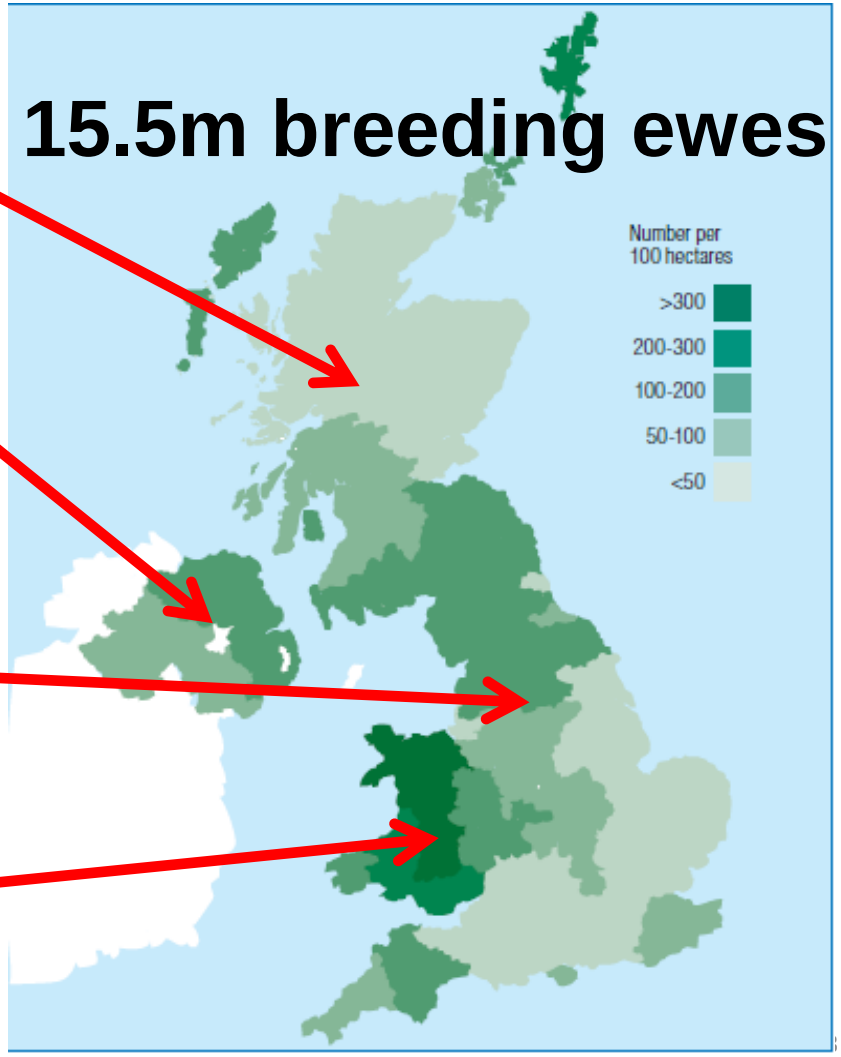


Scotland 3.3M

N. Ireland 0.9M

England 7M

Wales 4.3M



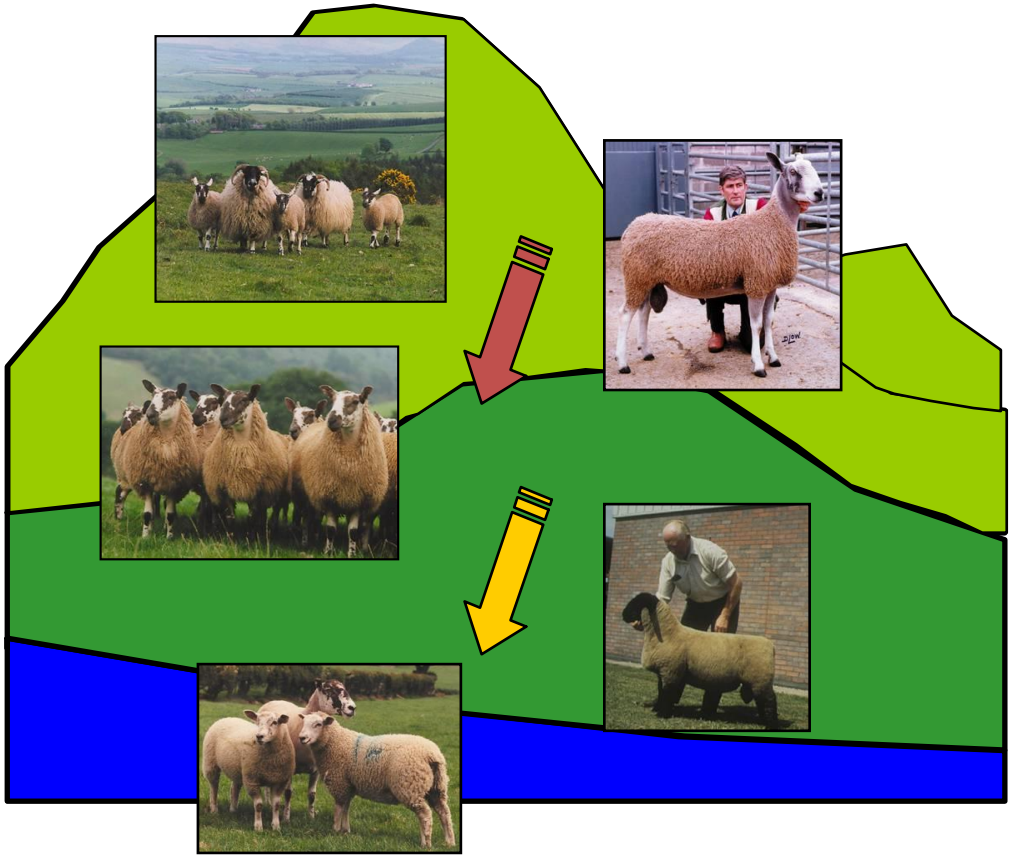
Source: Defra

‘Stratified’ UK sheep industry

Hill and Mountain

Uplands

Lowlands



Scottish Blackface

Welsh Mountain

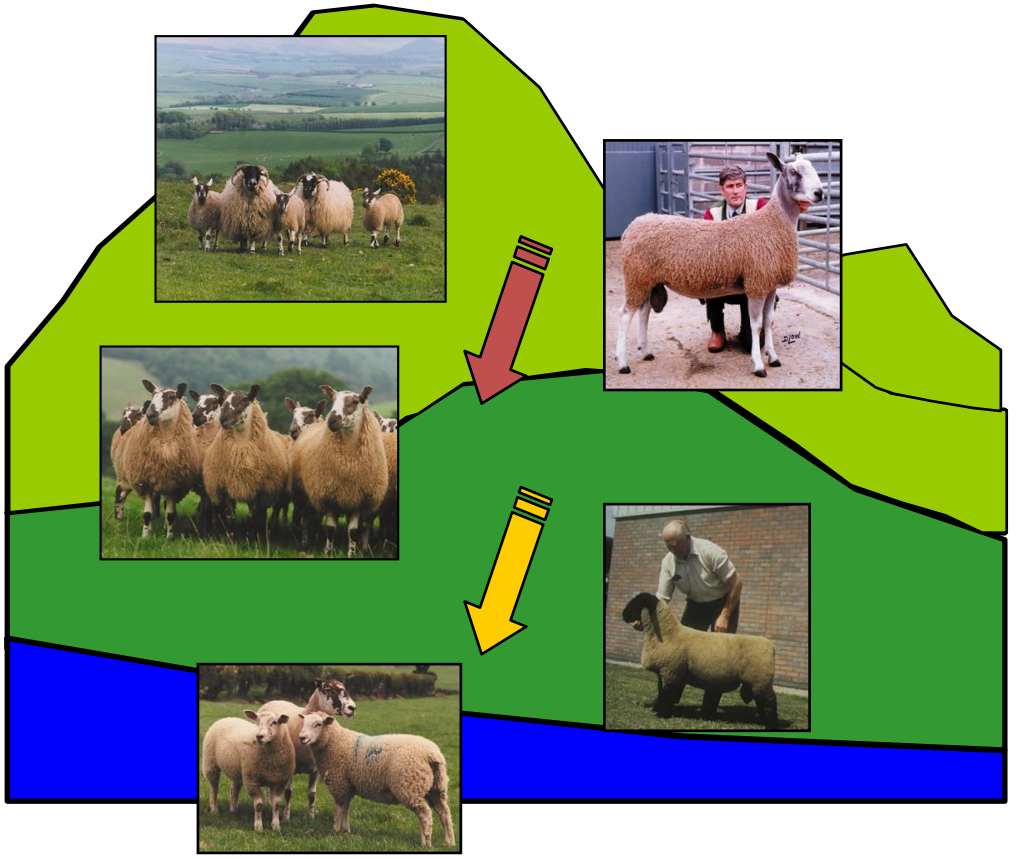
Swaledale

‘Stratified’ UK sheep industry

Hill and Mountain

Uplands

Lowlands



Prolific ‘longwool’ breeds

Longwool Ram Breed
Bluefaced Leicester

Longwool Ram Breed
Border Leicester

F1 sheep

(cross between hill breeds and prolific breeds) are the most numerous breeding ewe in the UK

Crossbred Ewe Breed
e.g. Scotch Mule

(Bluefaced Leicester x Scottish Blackface)

Crossbred Ewe Breed

English mule / ‘North Country mule’

Crossbred Ewe Breed

Welsh mule

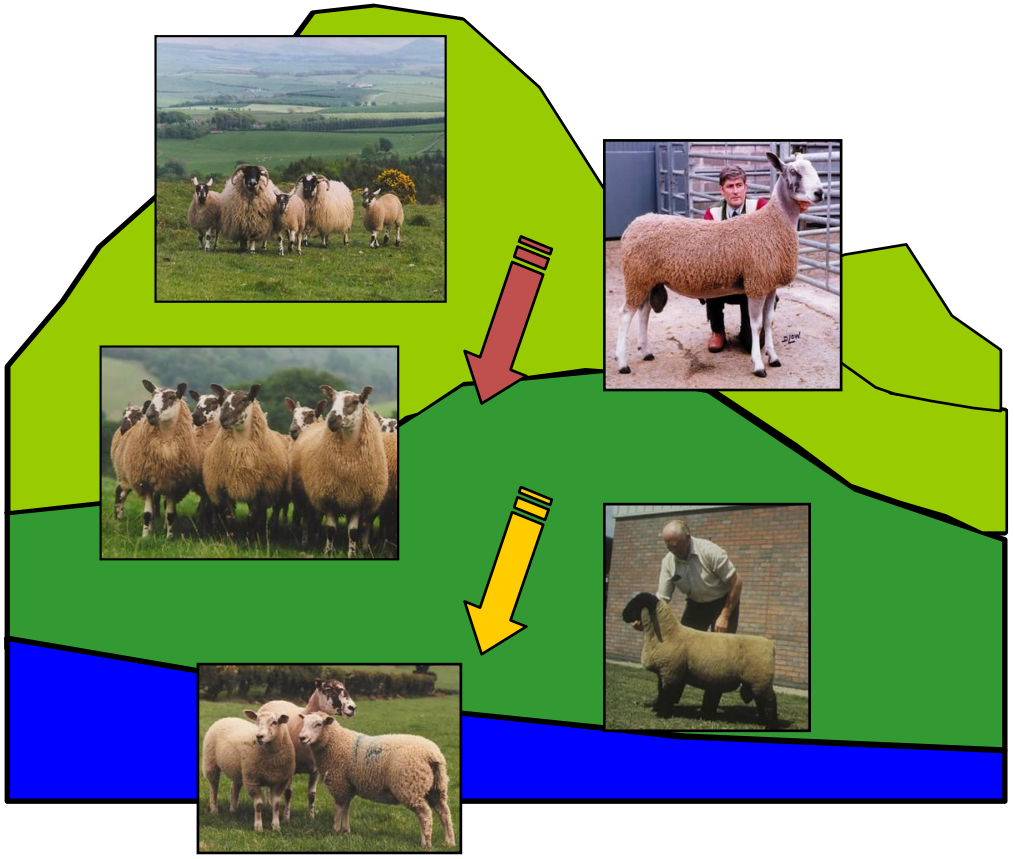
Bluefaced Leicester x Welsh Mountain, Beulah or Welsh Hill Speckled-face

‘Stratified’ UK sheep industry

Hill and Mountain

Uplands

Lowlands



Meat sheep breeds

Suffolk

Texel

Charollais

Advantages of this structure

- Breeds and their crosses fit well to their location and system of production
- Use of specialised males and females – breed improvement occurs in purebred
- Crossing system maximises use of hybrid vigour

Disadvantages of this system

- Supermarket nightmare ! - Very diverse end product
  - Only ~50% of lambs meet EUROP (fat and conformation) spec
- Capture of the value of genetic improvement is complex
- Biosecurity compromised with purchase of animals from other farms / markets

UK sheep industry is very diverse

- 83 ‘Purebreeds’
- Many more crosses and composite ‘breeds’

Only ~19 breeds have >10K

Native breeds

Jacob

Native breeds

Wensleydale

Dorset

Native breeds

Devon Longwool

Hampshire Down

Cute imports!

Genetic variation – ewe & lamb traits

Core elements:-

Number of offspring / year & survival (low h^2) – but high σ^2_p

Rate of growth and quality of carcass of offspring (Moderate h^2)

Variation in maternal behaviour

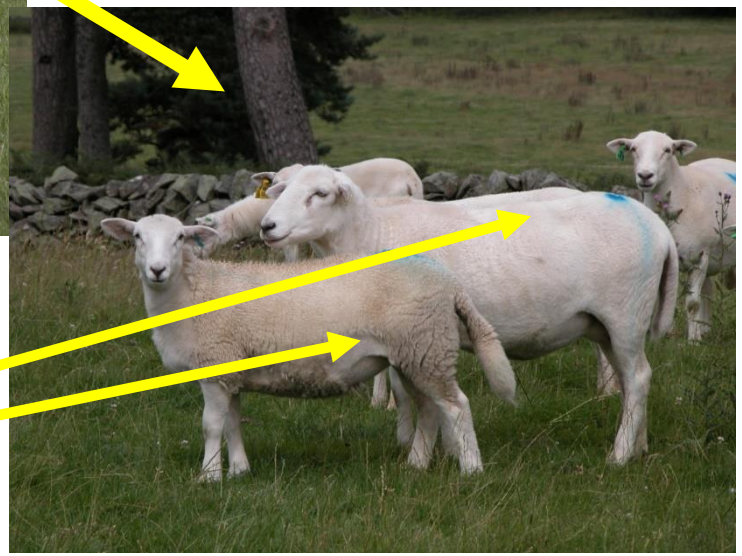
Within-breed estimates of heritability for maternal behaviour

0.13 Lambe, et al (2001). Animal Science **72,** p415-425

0.20 Brown et al (2015). Anim.Prod. Sci. 56:4 767-774

Wool shedding

Shedding wool in Spring (May)



August

- Ewe shedding complete
- Lamb shedding coat

Exploiting natural genetic variation

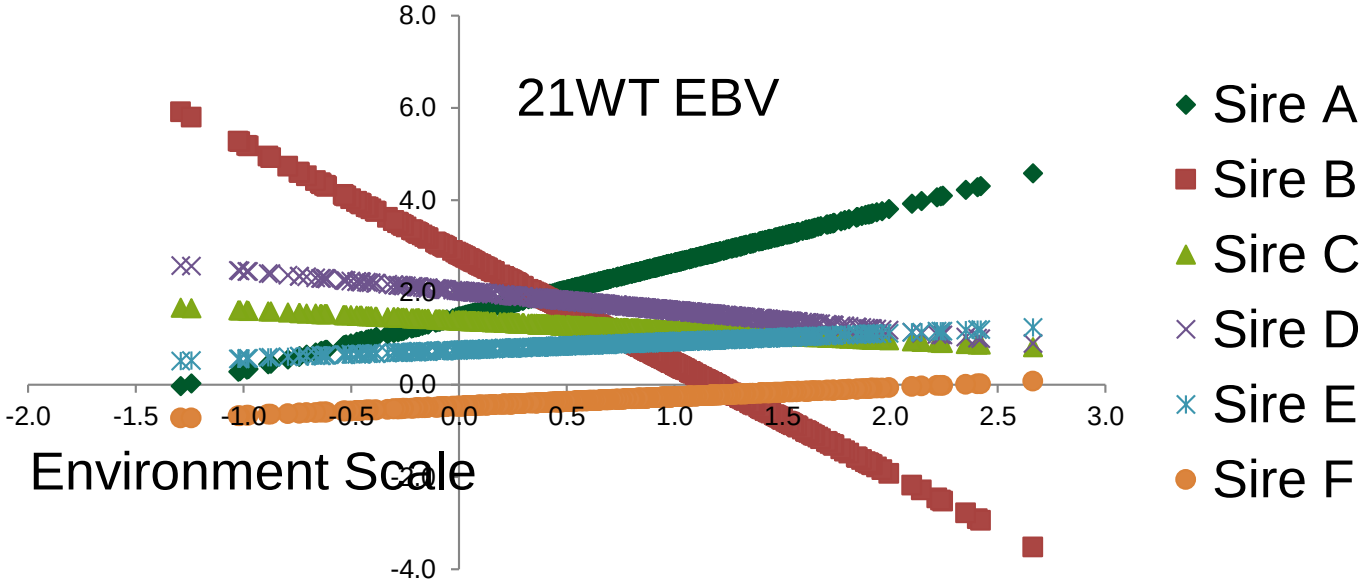
Genetic propensity to shed fleece

Heritability 0.65-0.8 **Matika et al 2013. Anim.Genet** 44(6):742-9;

0.54 **Pollot, 2011 J Anim Sci** 89:2316-25

Adapting to climate change

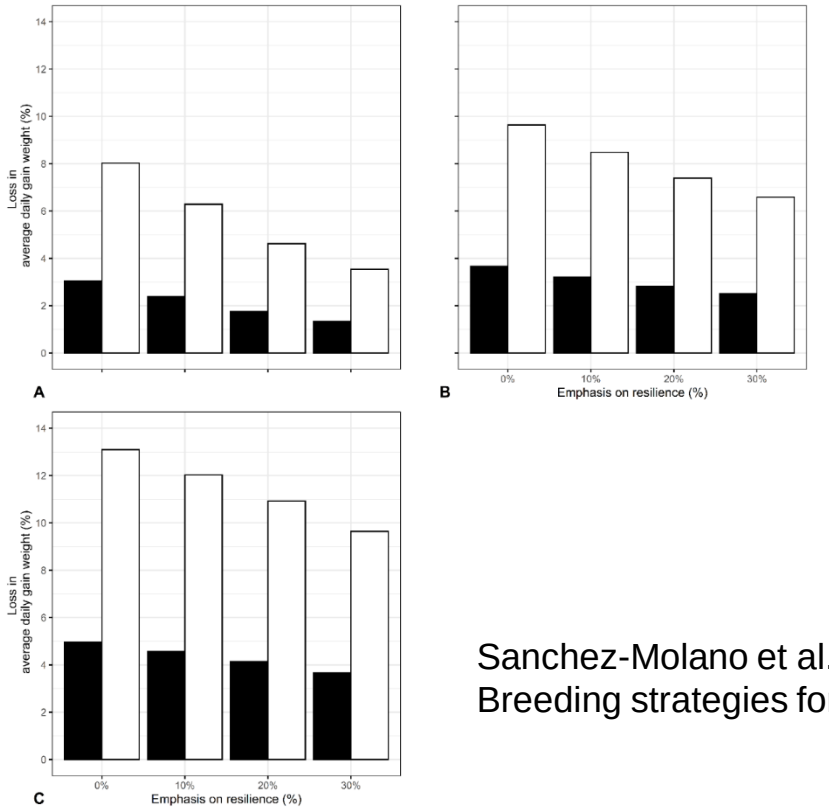
Sheep – evidence of G x E



- Scaling and re-ranking observed.
- 'Robust' sires, and sires suited to specific environments identified.

McLaren et al. 2015, Animal 9:10 1624-1634

Genetic variation in resilience to weather

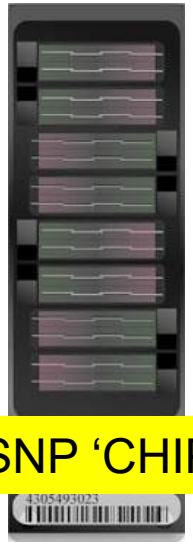


1 deg = white bar

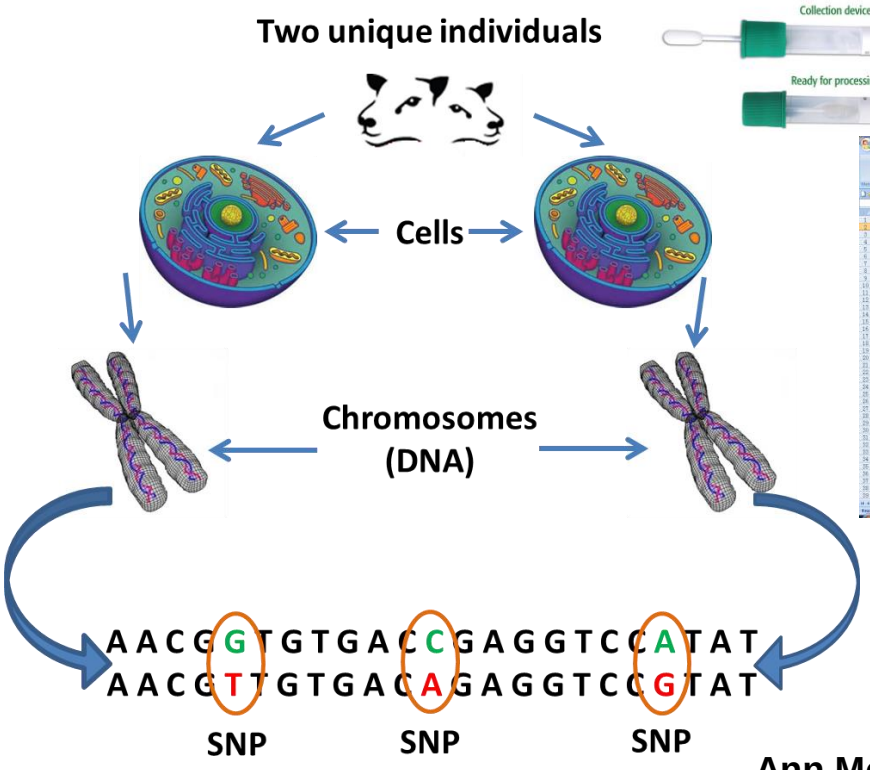
2.6 deg = black bar

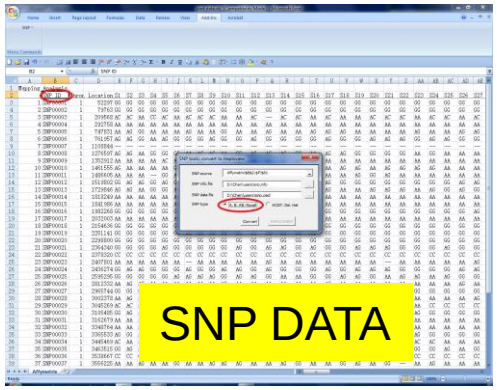
Sanchez-Molano et al., 2020. In press, BMC Genetics.
Breeding strategies for animal resilience to weather variation in meat sheep

Using genomic information



SNP ‘CHIP’





SNP DATA

Ann McLaren

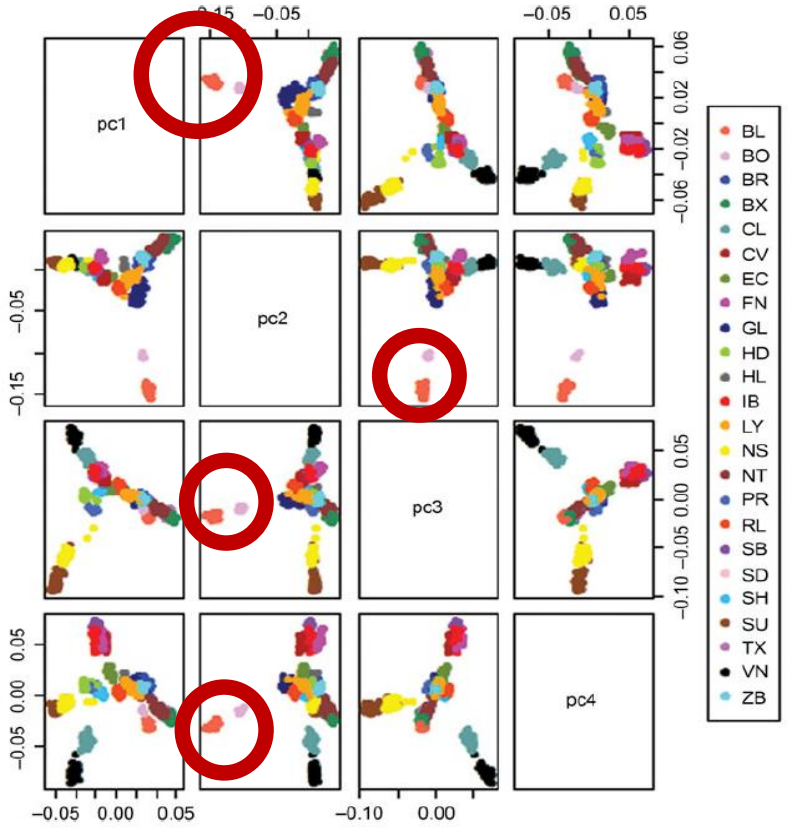
Knowledge of population structure & breed composition - SNP data

Important for:-

- Design of optimal (cross)breeding strategies
  - maximise non-additive genetic effects
-
- Maintaining flockbook integrity
  - authenticating animals being registered

- QA for the genotyping process – amongst other things..

Variation between populations



Bluefaced Leicester

Border Leicester

O Brien et al 2020 Animal14:3, pp 464–474

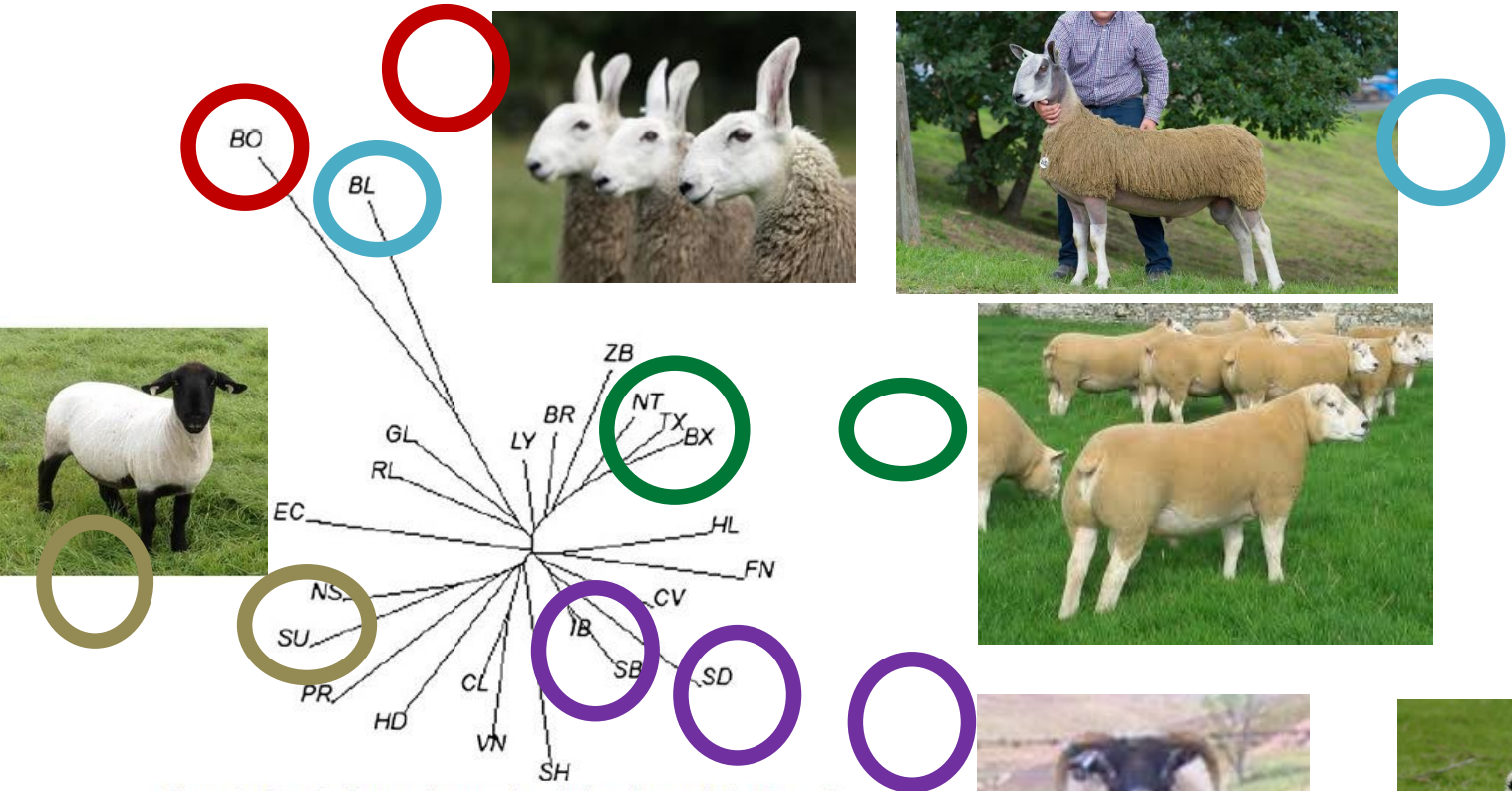
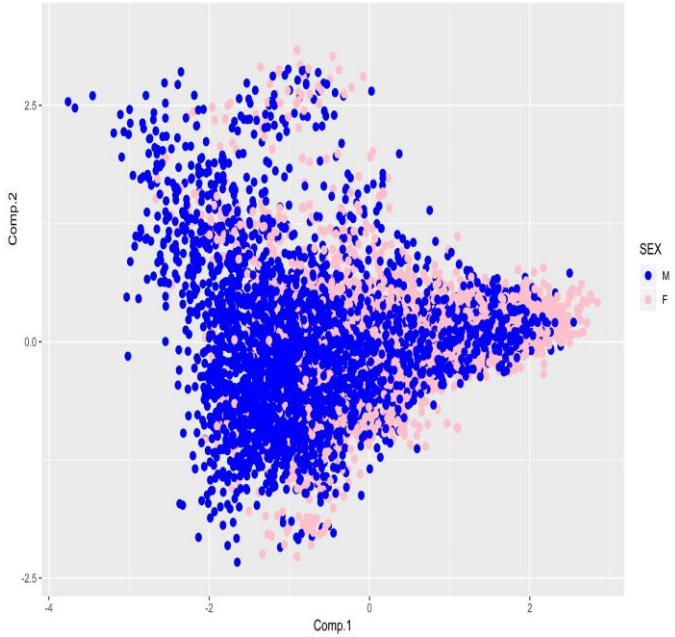


Figure 3 Genetic distance between breeds based on pairwise Fst estimates. Breeds included in the analysis were Bluefaced Leicester (BL), Border Leicester (BO), Belclare (BR), Beltex (BX), Charollais (CL), Cheviot (CV), EasyCare (EC), Finn (FN), Galway (GL), Hampshire Down (HD), Highlander (HL), Irish Blackface (IB), Lleyn (LY), New Zealand Suffolk (NS), New Zealand Texel (NT), Primera (PR), Rouge de l'Ouest (RL), Scottish Blackface (SB), Swaledale (SD), Shropshire (SH), Suffolk (SU), Texel (TX), Vendeen (VN), and Zwartble (ZB).

O Brien et al 2020 Animal14:3, pp 464–474

Genomic selection - testing population structures



Texel PCA (UK)

Kaseja 2019

Variation within populations
Inbreeding measurement(s)

- Standard F statistic
- % homozygosity
- ‘Van Raden method’

VanRaden 2007. Genomic measures of relationship and inbreeding. Interbull Bull. 37: 33-36.

VanRaden 2008. Efficient methods to compute genomic predictions. J. Dairy Sci. 91: 4414-4423

VanRaden et al. 2011. Genomic inbreeding and relationships among Holsteins, Jerseys, and Brown Swiss. J. Dairy Sci. 94: 5673-5682.

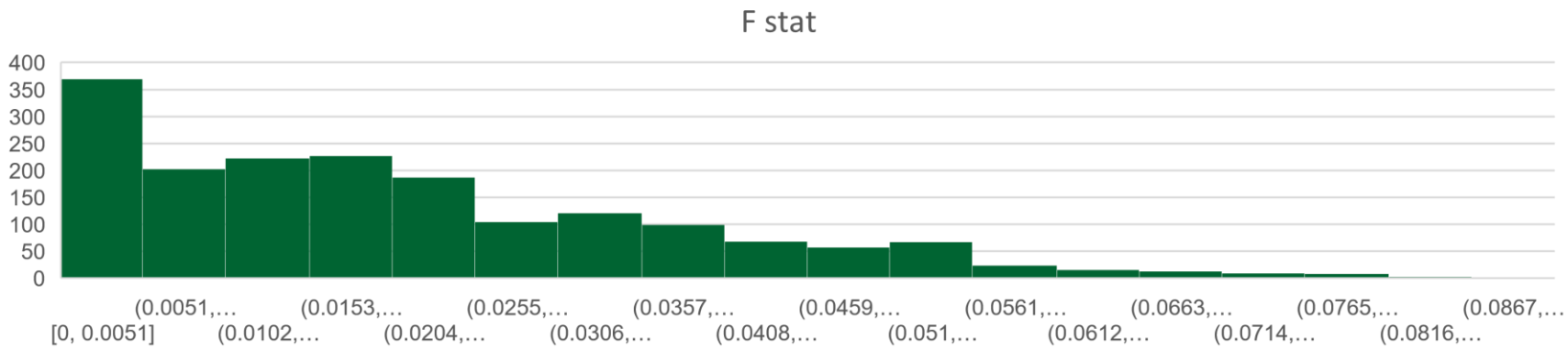
Inbreeding measurement – example of Scottish Blackface n=1801

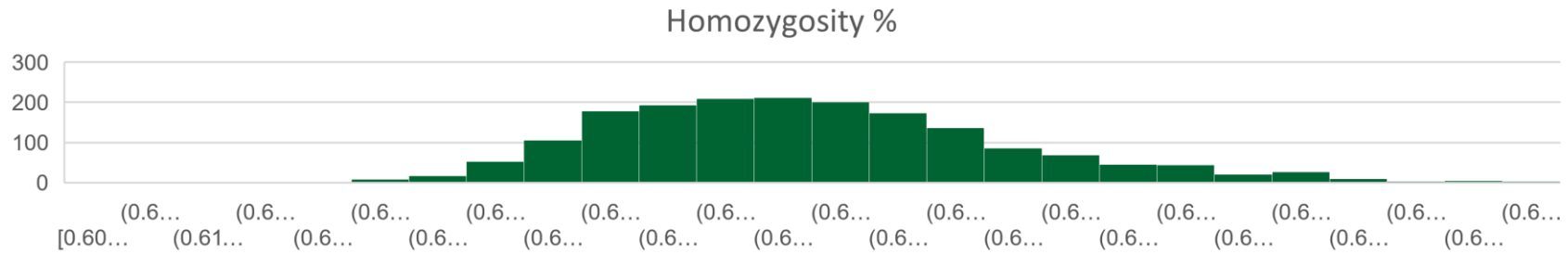
50K SNP used

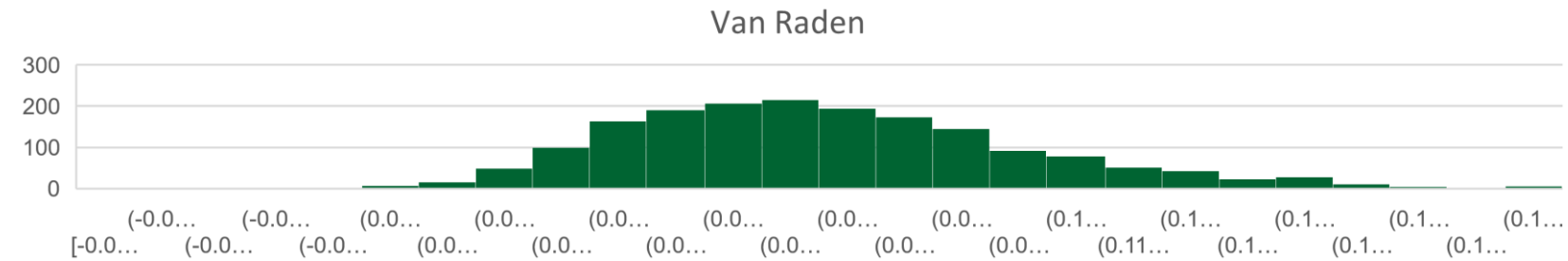
	F statistic	Homozy %	Van Raden
Average	0.02	0.64	0.07
Min-max	0 – 0.09	0.60 - 0.68	-0.03-0.18
Corr with ped	1	0.56	0.56

SBF= most numerous maternal purebred in UK

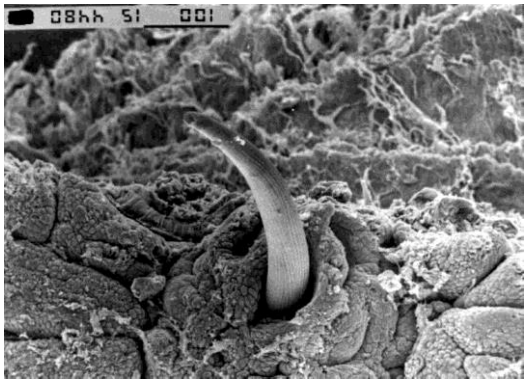
Banos 2020, pers. comm


F stat
400
350
300
250
200
150
100
50
0
[0, 0.0051]
(0.0051,…
(0.0102,…
(0.0153,…
(0.0204,…
(0.0255,…
(0.0306,…
(0.0357,…
(0.0408,…
(0.0459,…
(0.051,…
(0.0561,…
(0.0612,…
(0.0663,…
(0.0714,…
(0.0765,…
(0.0816,…
(0.0867,…


Homozygosity %
300
200
100
0
[0.60…
(0.61…
(0.6…


Van Raden
300
200
100
0
[-0.0…
(-0.0…
(0.0…
(0.1…
(0.11…

Hard to measure / expensive / measured later in life traits



Disease

Smarter
SMAll RuminanTs breeding for Efficiency and Resilience

GrassToGas

Feed intake

(photo courtesy of H.Wishart)

Diversity of sheep in the UK – do we have a problem or an opportunity?

- Phenotypically and genetically diverse
  - Exploit diversity to meet new breeding goals – adapt to economic changes
- New methodologies to identify more robust animals
  - Resilience to changes in weather etc.
- Genomic tools – balancing genetic gain and inbreeding

.. UK sheep industry biggest problem…

Acknowledgements

Ann McLaren
Nicola Lambe
Maureen Steel
Sebastian Mucha
Karolina Kaseja
Georgios Banos
Enrique Sanchez-Moleno

SRUC

Leading the way in Agriculture and Rural Research, Education and Consulting