Breeding for disease resistance and using genomics in sheep breeding

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

Why worry about health traits?

- ‘Narrow’ selection for ‘production only’ traits in other species has led to
  - Deterioration in health & fitness of > 100 different traits

- Elite breeding flocks
  - Offspring used on commercial farms

- Improving HOST resistance is beneficial
  - Animal welfare
  - Resistance to anthelmintics (wormers)

- $ £ $ £

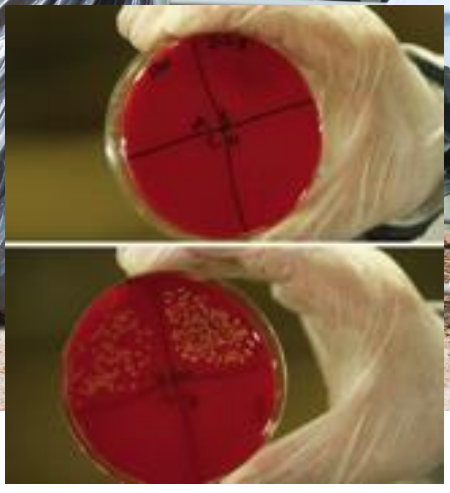
We spend a lot of time 'Managing' the problems of disease

What kind of life?

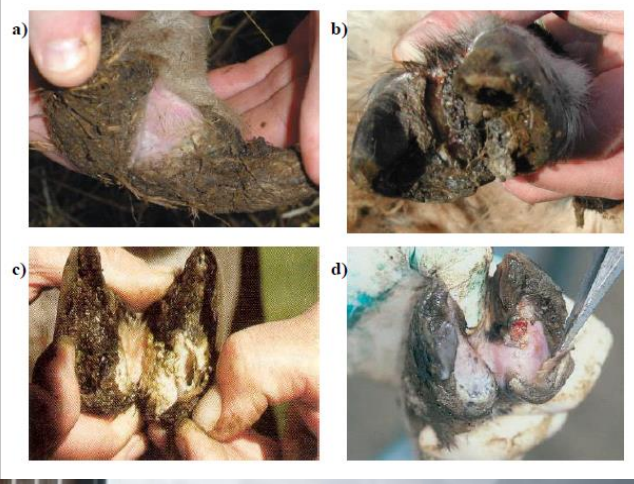
This??

Or this??

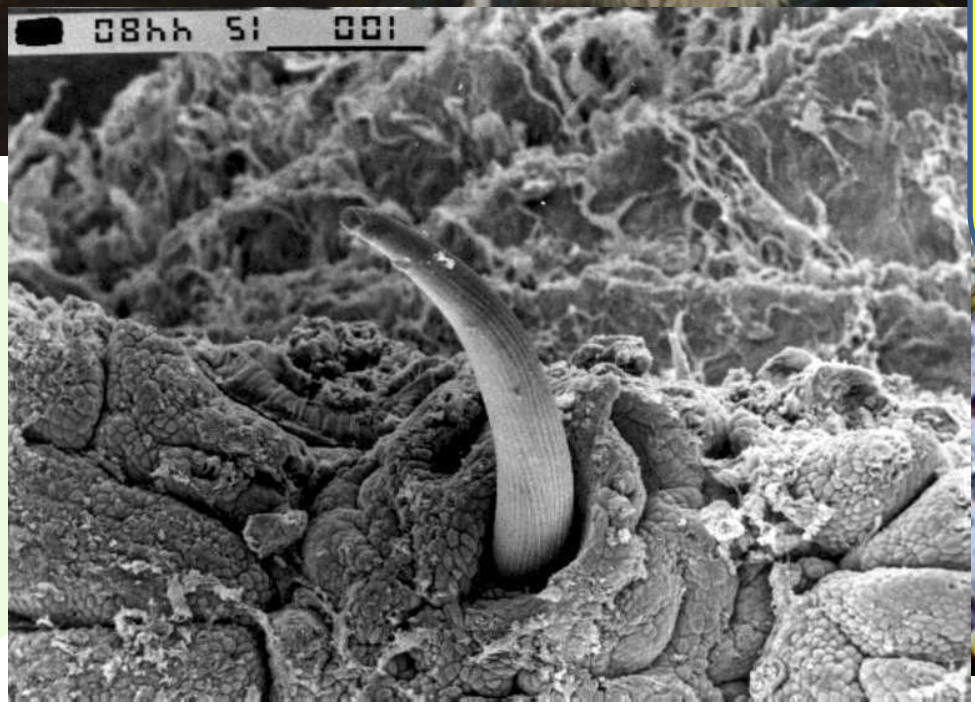
MASTITIS

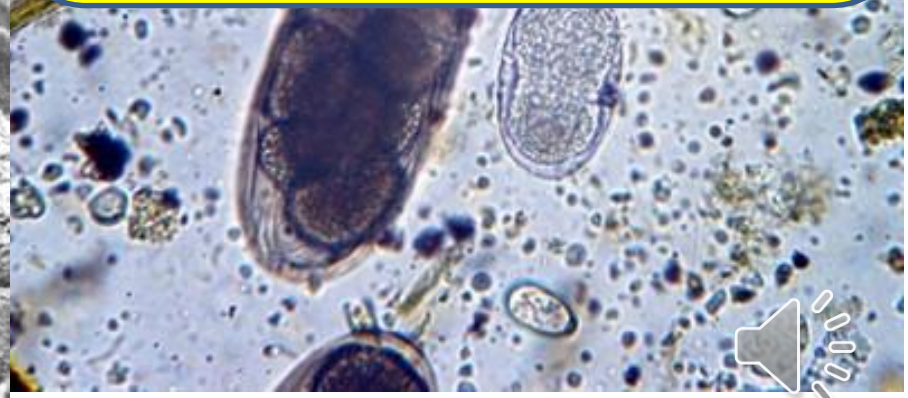


FOOTROT



Internal parasites





Recording disease – overcoming barriers

- Differ between years
- Differ between scorers (people)
- Differ between flocks

- NEED WELL-RECORDED POPULATION

- IMPORTANT TO DEFINE THE TRAIT / DISEASE

Number of records - Texel

Year	No. ewes
2015*	3,339
2016*	3,482
2017	1,712
2018	1,652

> 10,000 records

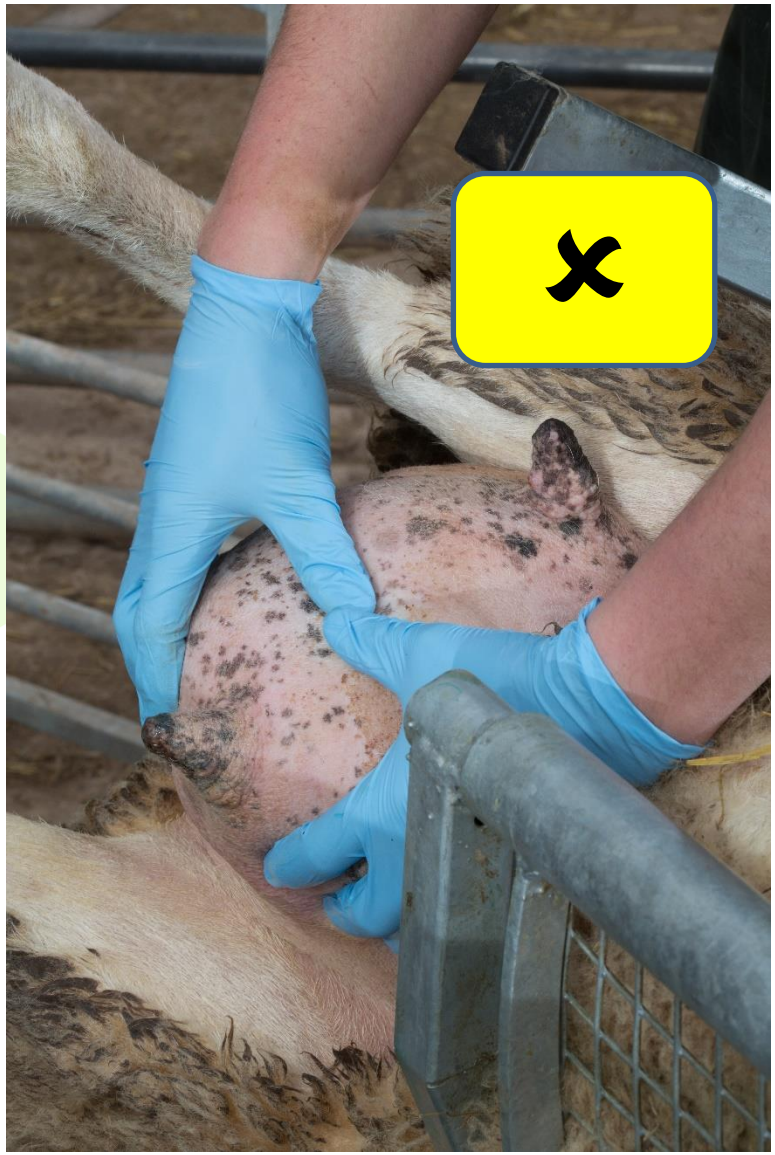
8,764 genotypes

*ewes scored twice @ 38 & 11

Milk sampling & nasal swab

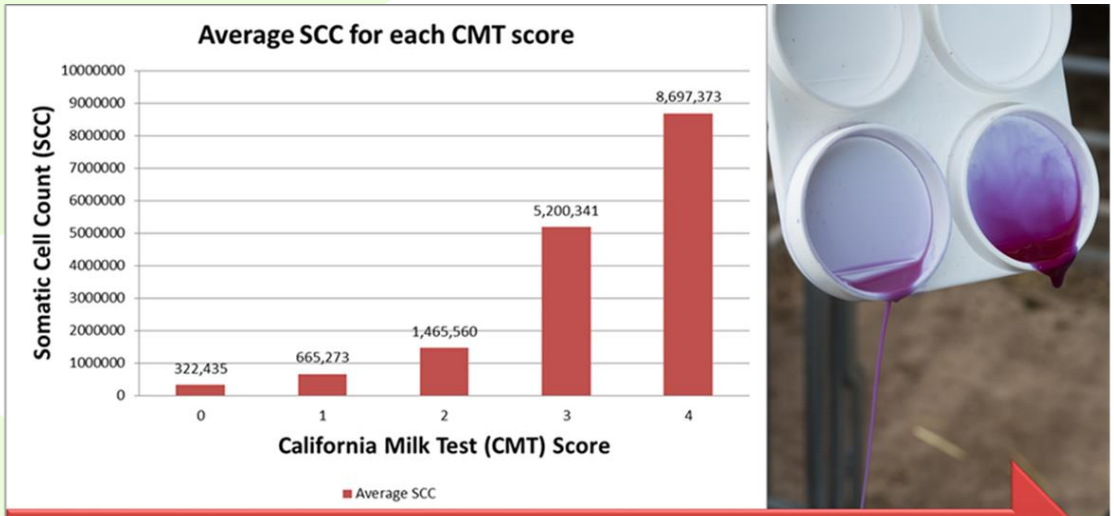
WHAT DID WE FIND OUT?

Mastitis ‘phenotyping’

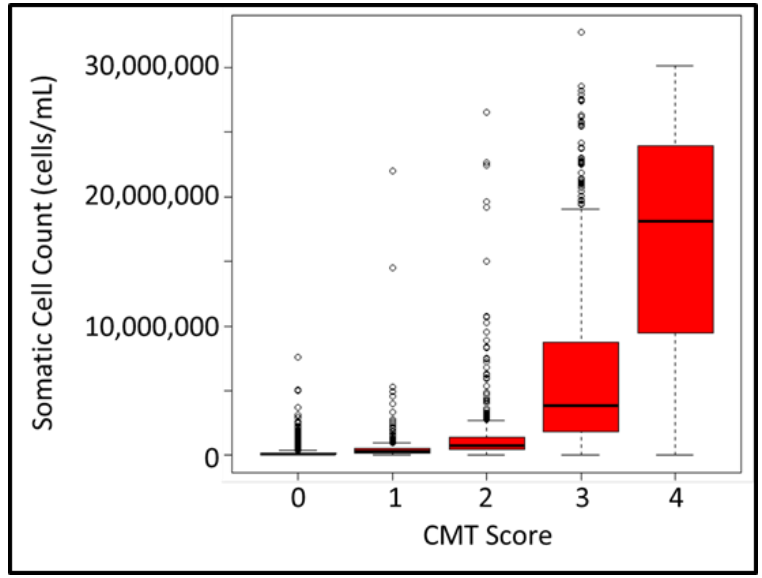


Somatic Cell Count vs CMT?

- Good predictor ✓



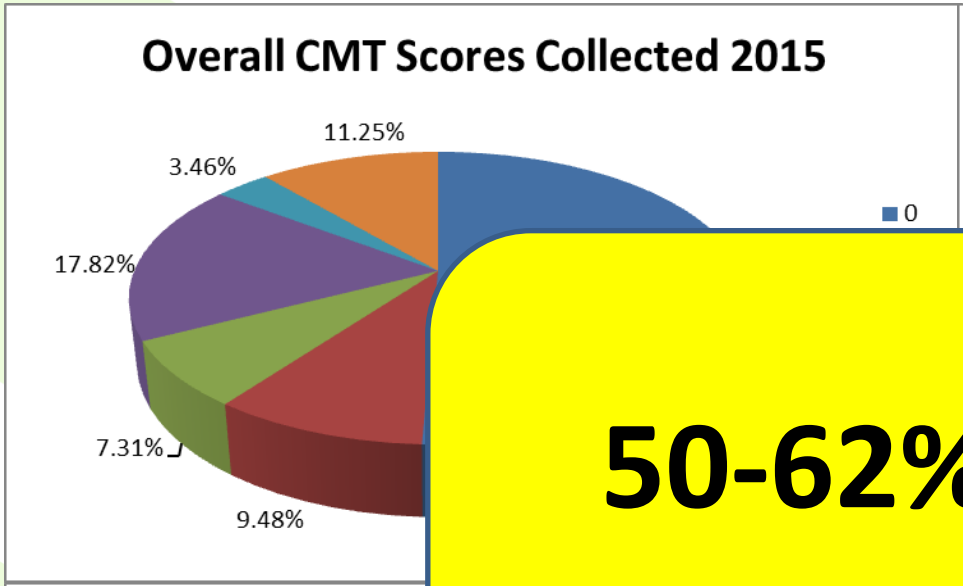
Score 0 (healthy) Score 4 (serious mastitis infection)

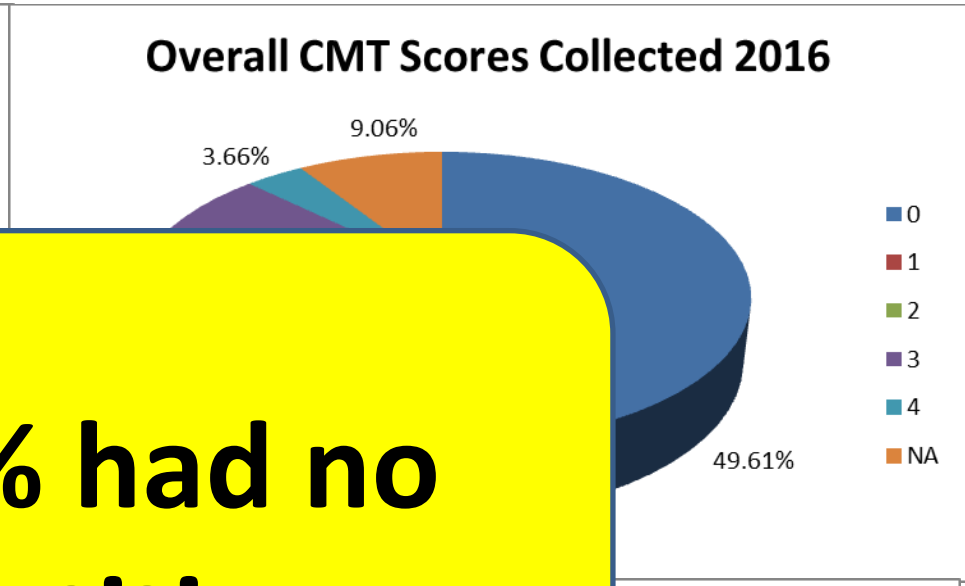


Same (ish) genes

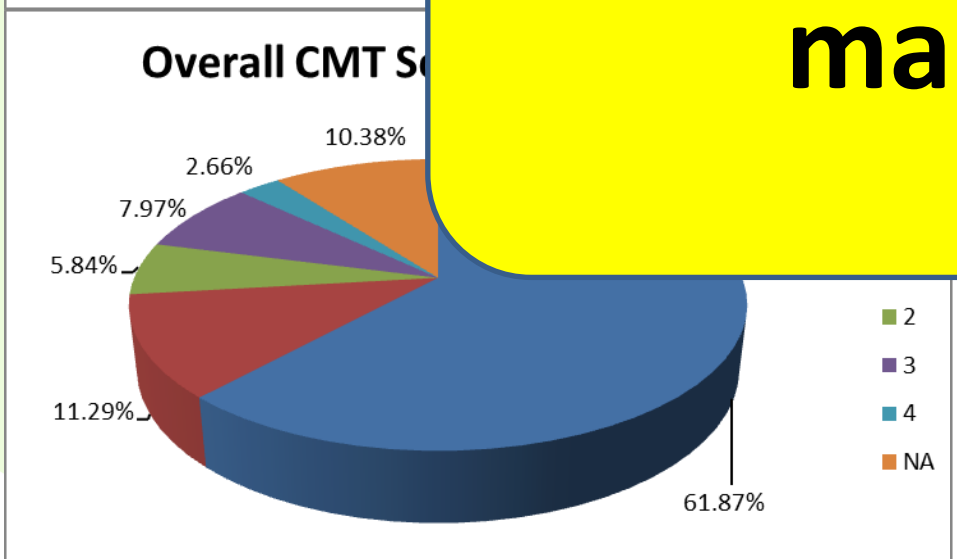
Trait	Heritability
CMT	0.14 (0.08)
SCC	0.23 (0.08)

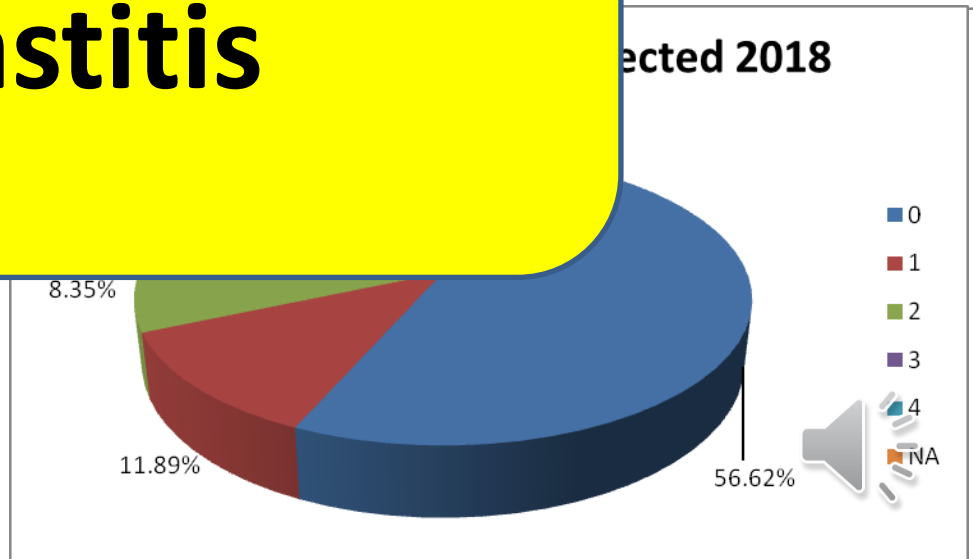
CMT scores - summary



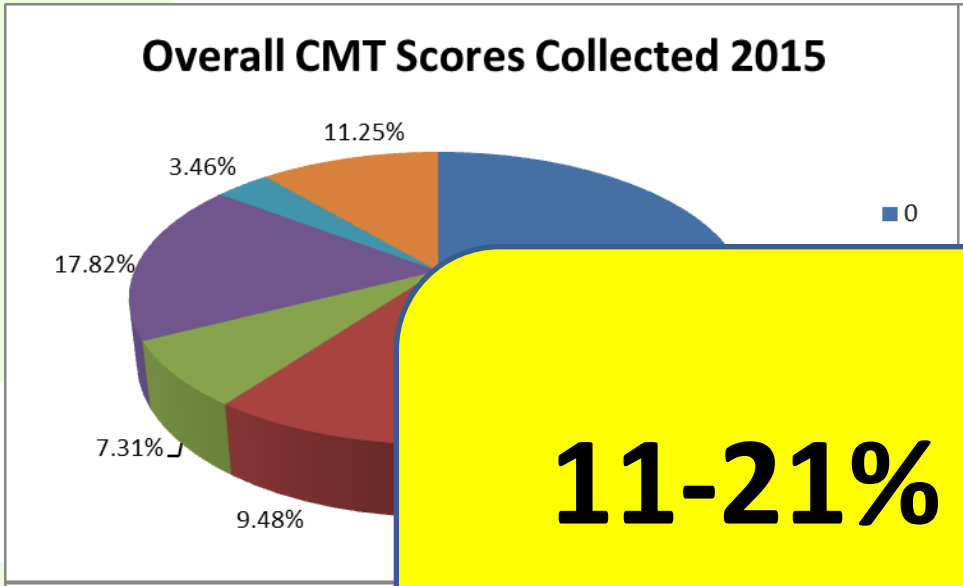


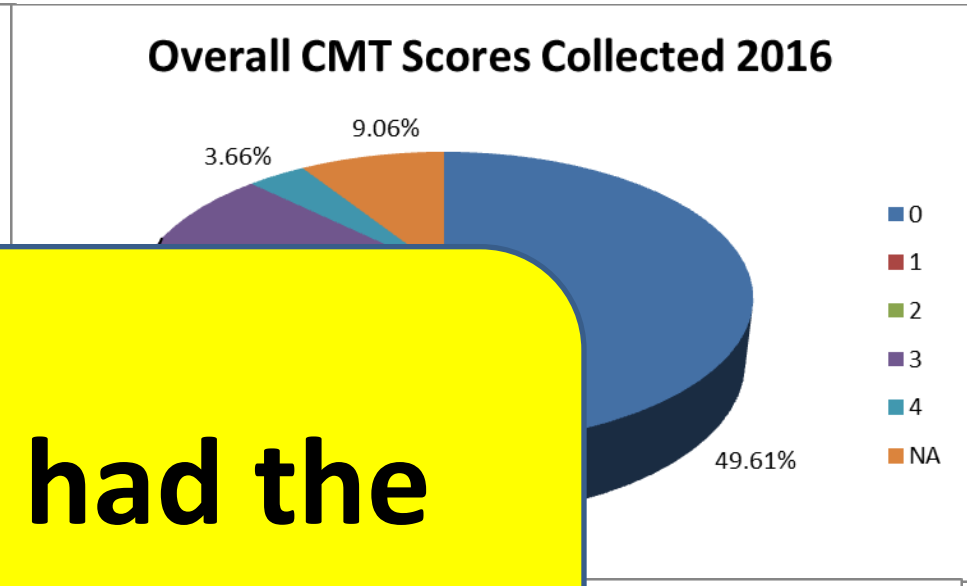
50-62% had no mastitis



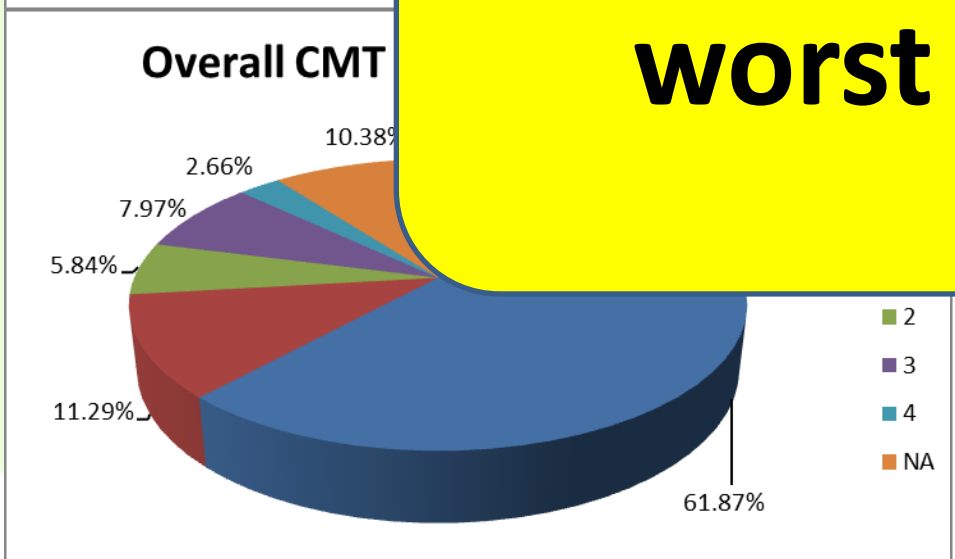


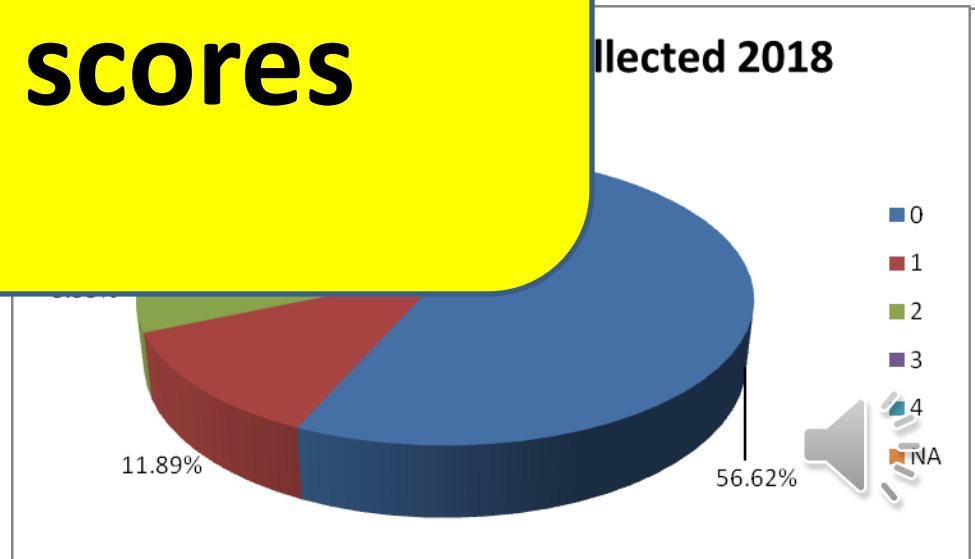
CMT scores - summary



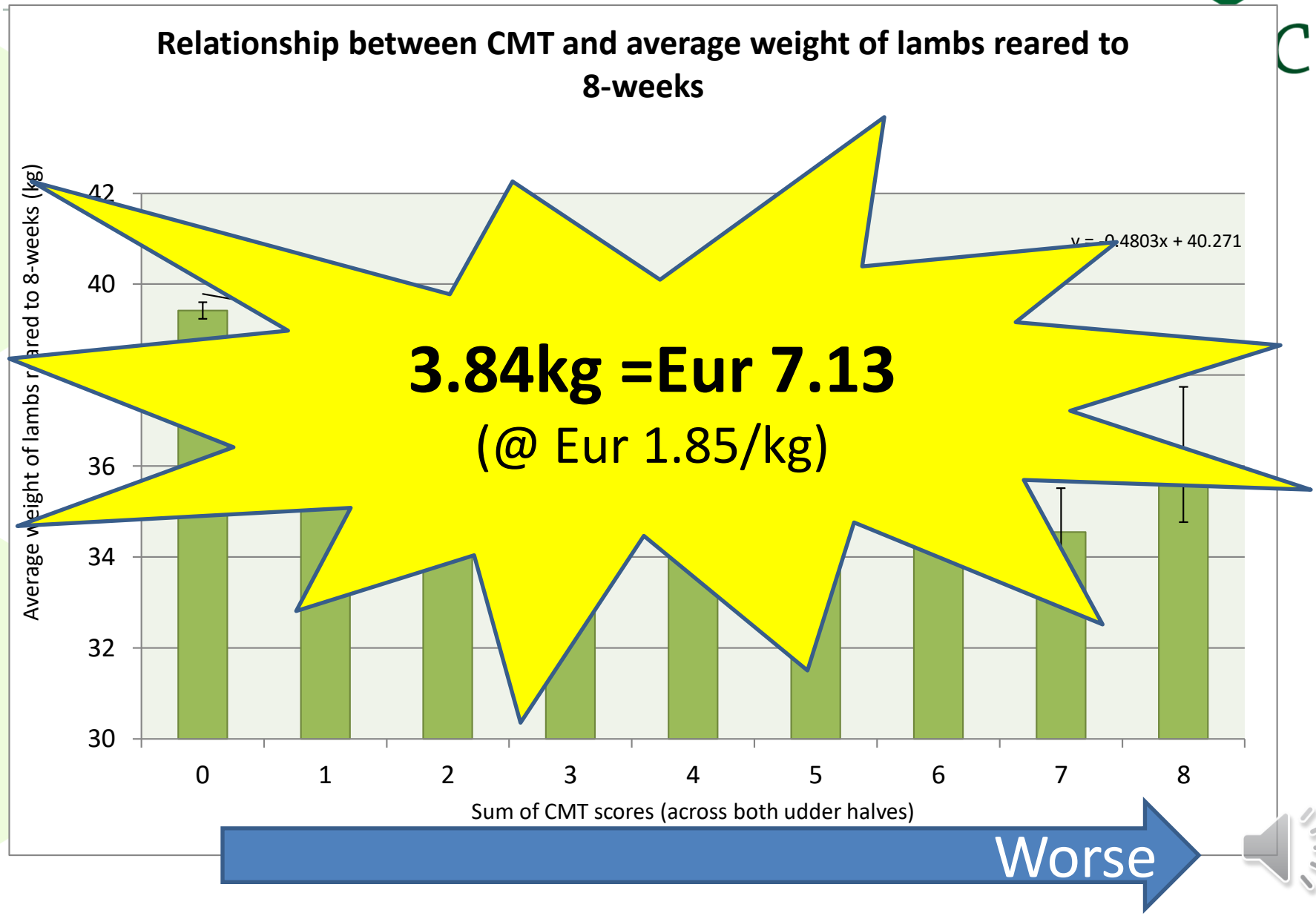


11-21% had the worst scores





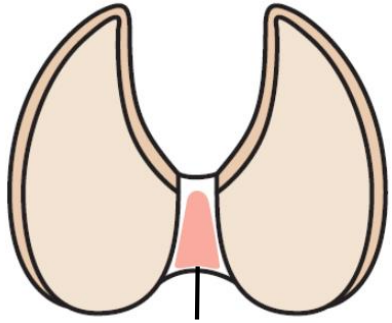
More mastitis = lower lamb weight




What about
Footrot?

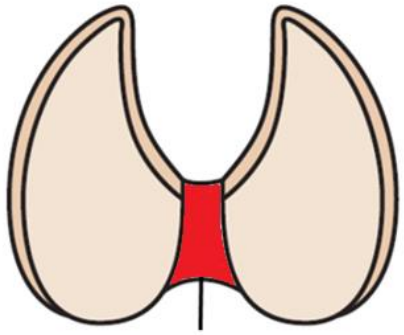
Foot scoring method

- 1: Non-specific inflammation of the interdigital skin



Interdigital dermatitis

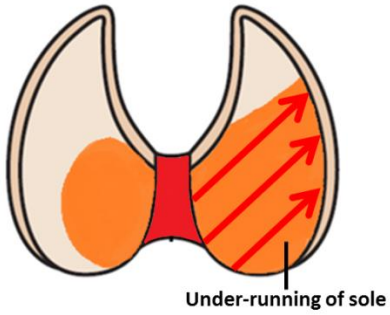
- 2: Necrotic, severe inflammation



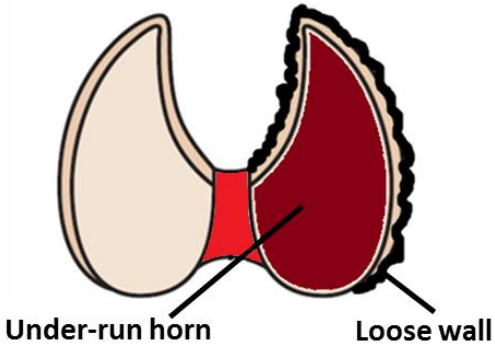
Severe inflammation

Foot scoring method

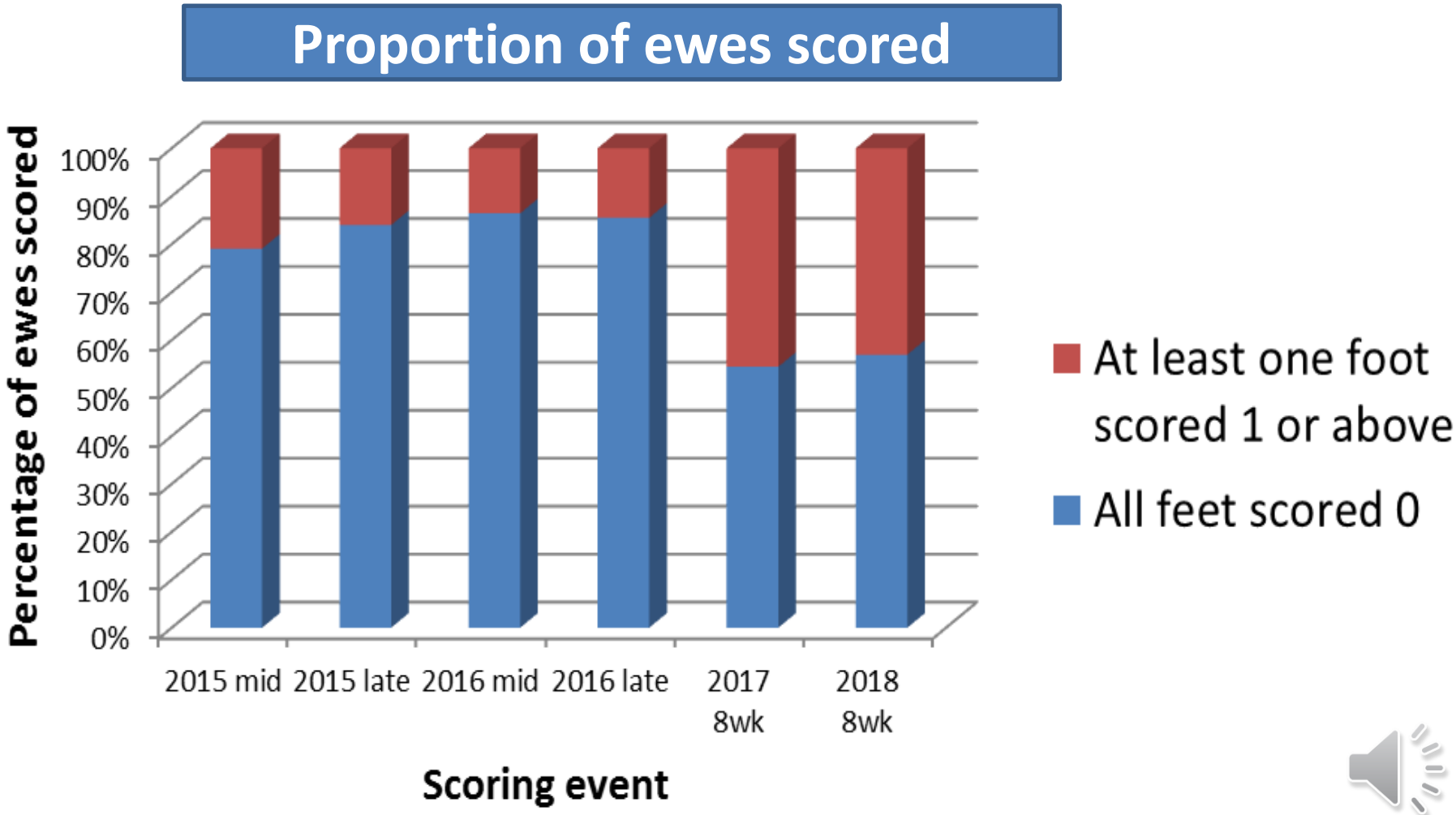
- 3: Under-run of the sole, restricted to soft horn of the heel



- 4: Under-run of the sole of the foot including the hard horn of the toe and wall



Foot scores


Proportion of ewes scored
Percentage of ewes scored
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2015 mid
2015 late
2016 mid
2016 late
2017 8wk
2018 8wk
Scoring event
At least one foot scored 1 or above
All feet scored 0

Resistance to Footrot is under low to moderate genetic control

SRUC

Heritability 0.18

Breeding resistance to footrot

65

- Foot scoring useful tool to differentiate footrot & other hoof lesions
- 5-point scale, h^2 ~0.2

Conington et al., 2008 *Vet Res Comm.*
Nieuwhof et al., 2008 *Animal*

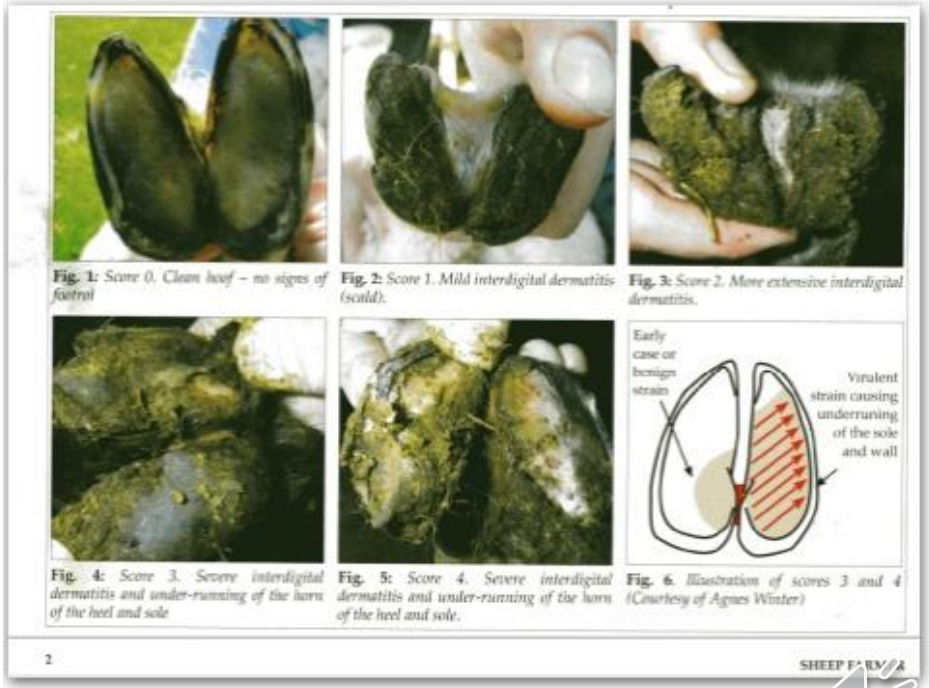


Fig. 1: *Score 0. Clean hoof – no signs of footrot*

Fig. 2: *Score 1. Mild interdigital dermatitis (scald).*

Fig. 3: *Score 2. More extensive interdigital dermatitis.*

Fig. 4: *Score 3. Severe interdigital dermatitis and under-running of the horn of the heel and sole*

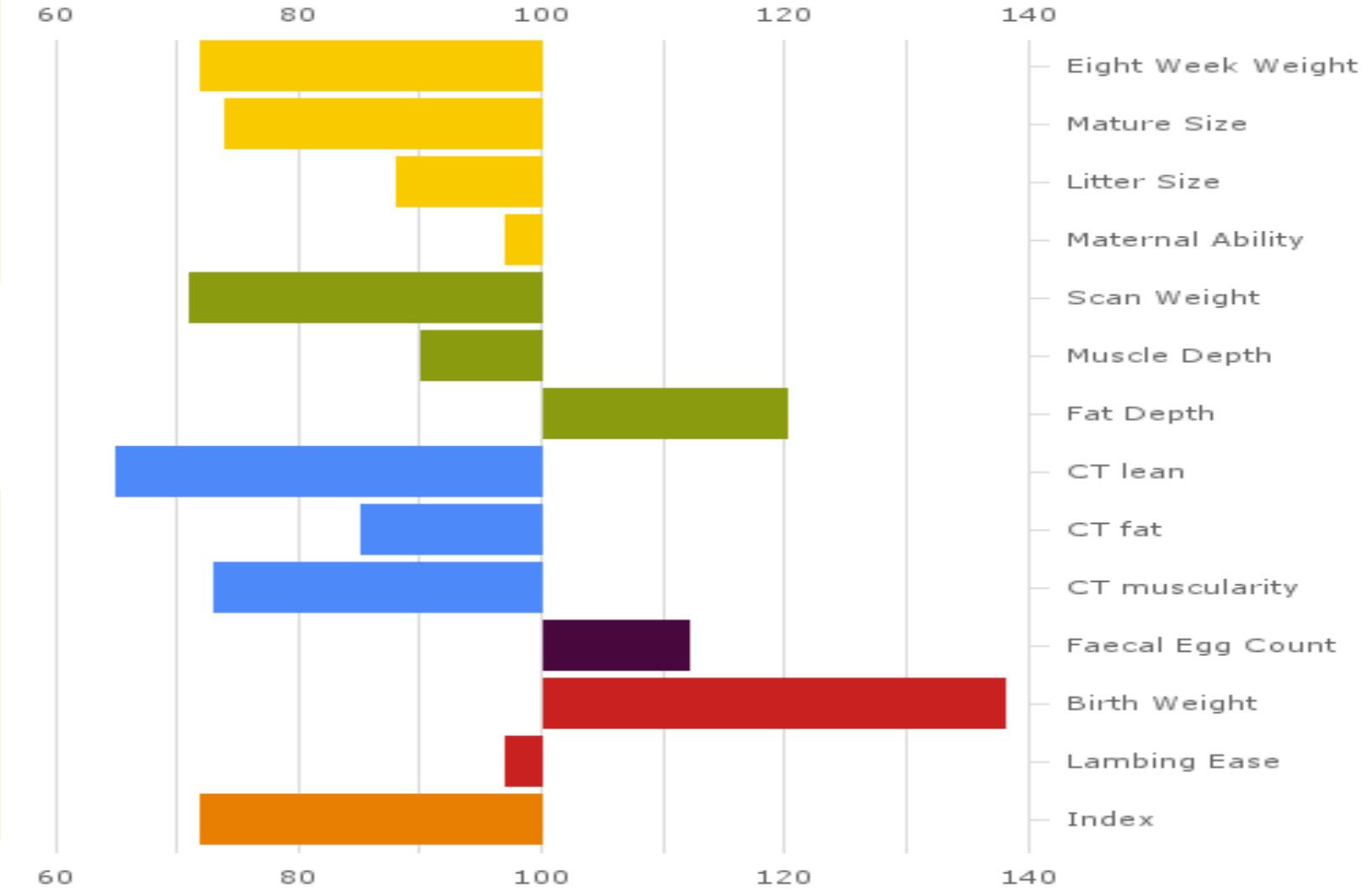
Fig. 5: *Score 4. Severe interdigital dermatitis and under-running of the horn of the heel and sole.*

Fig. 6. *Illustration of scores 3 and 4 (Courtesy of Agnes Winter)*

Where does genomics fit?

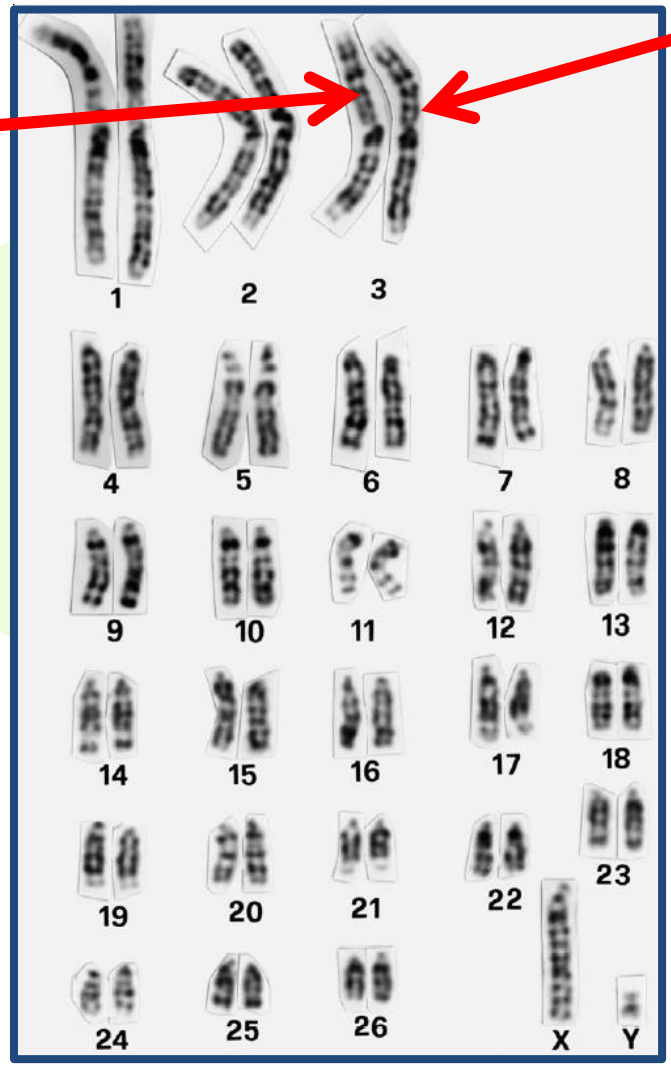
Sheep image courtesy of AHDB

Need an established breeding programme 1st



Whole genome approach

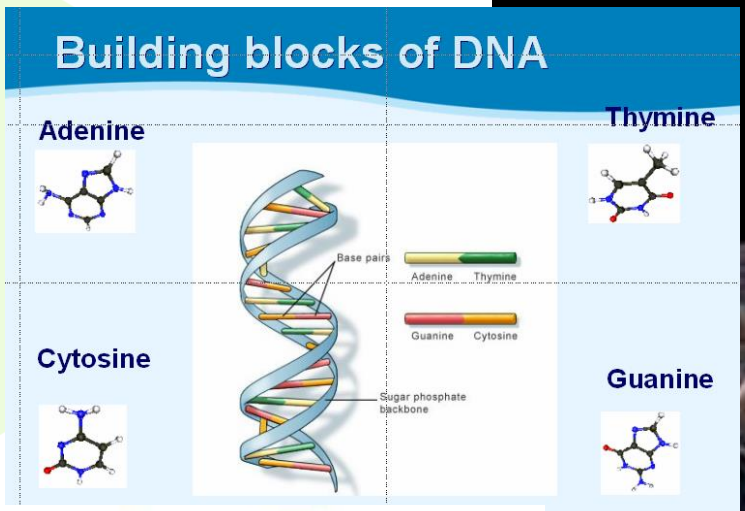
Copy from dam

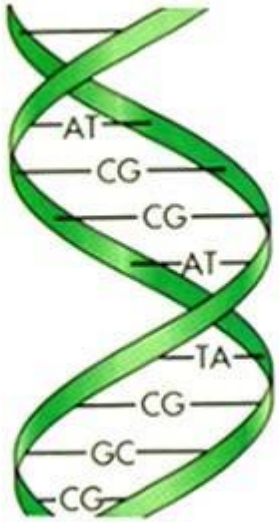


Copy from sire

Sheep have 26 Pairs of Chromosomes (+ X & Y)

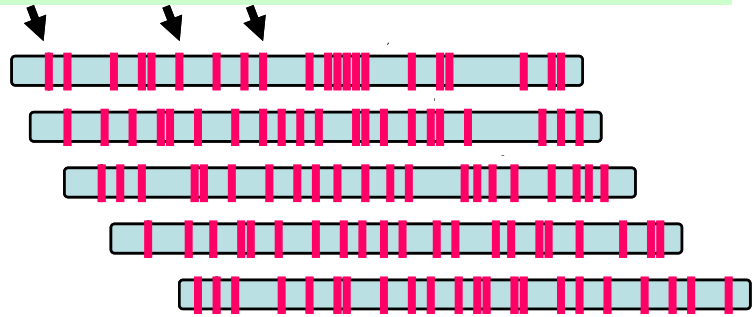
Genetic ‘code’





Genomic selection

Markers (SNPs) spaced across all chromosomes



- Dense map of markers (SNPs) across the genome (50K)

	SNP 1	SNP 2	SNP 3	SNP 4	SNP ……
Trait1	●	●	●	●	
Trait2	●	●	●	●	
Trait3	●	●	●	●	
Trait4	●	●	●	●	
Trait…	●	●	●	●	

What is a SNP?

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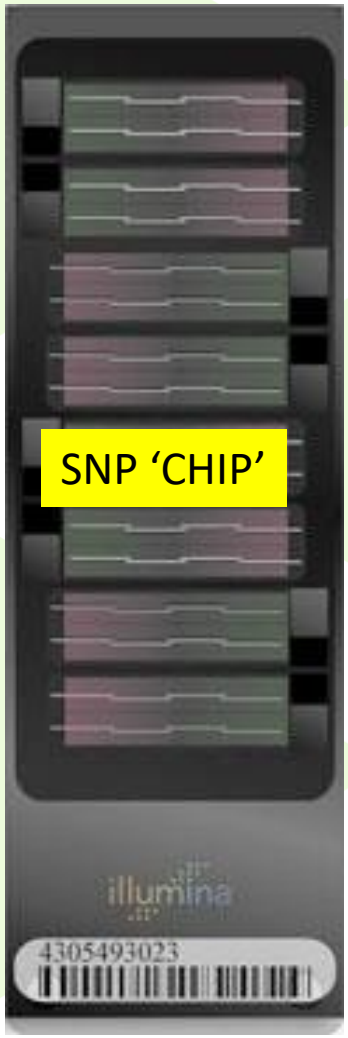
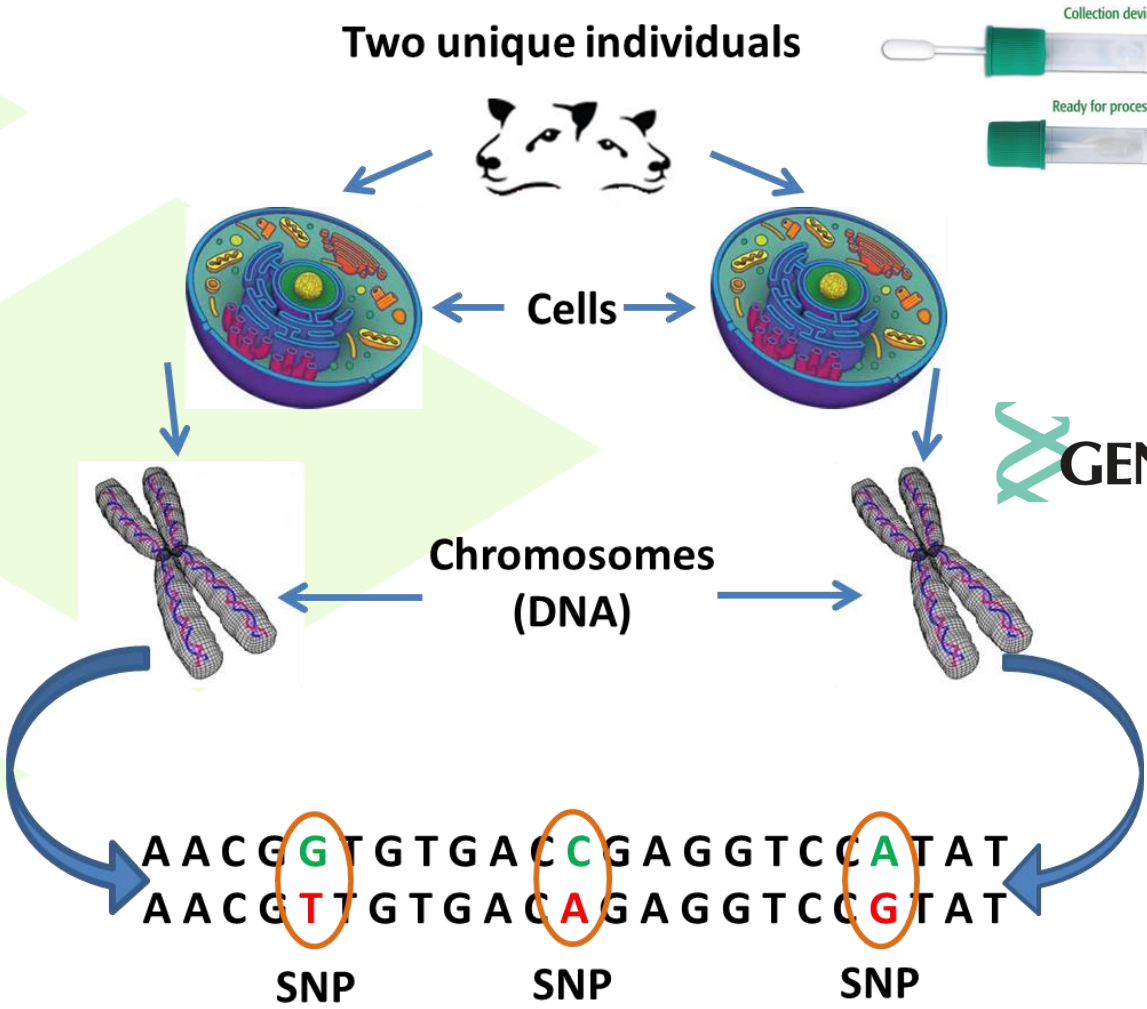
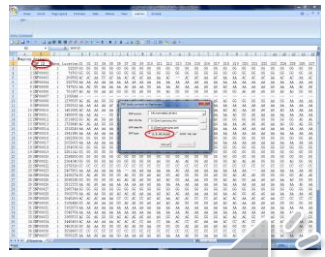


SNP 'CHIP'



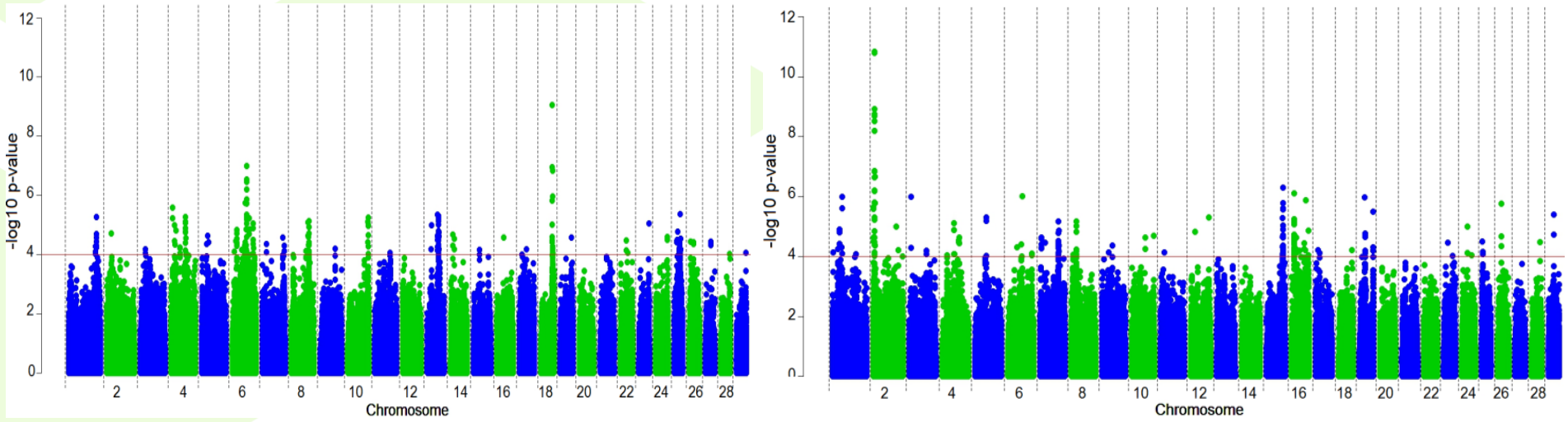
GENESEEK
a Neogen® Company



SNP 'patterns'

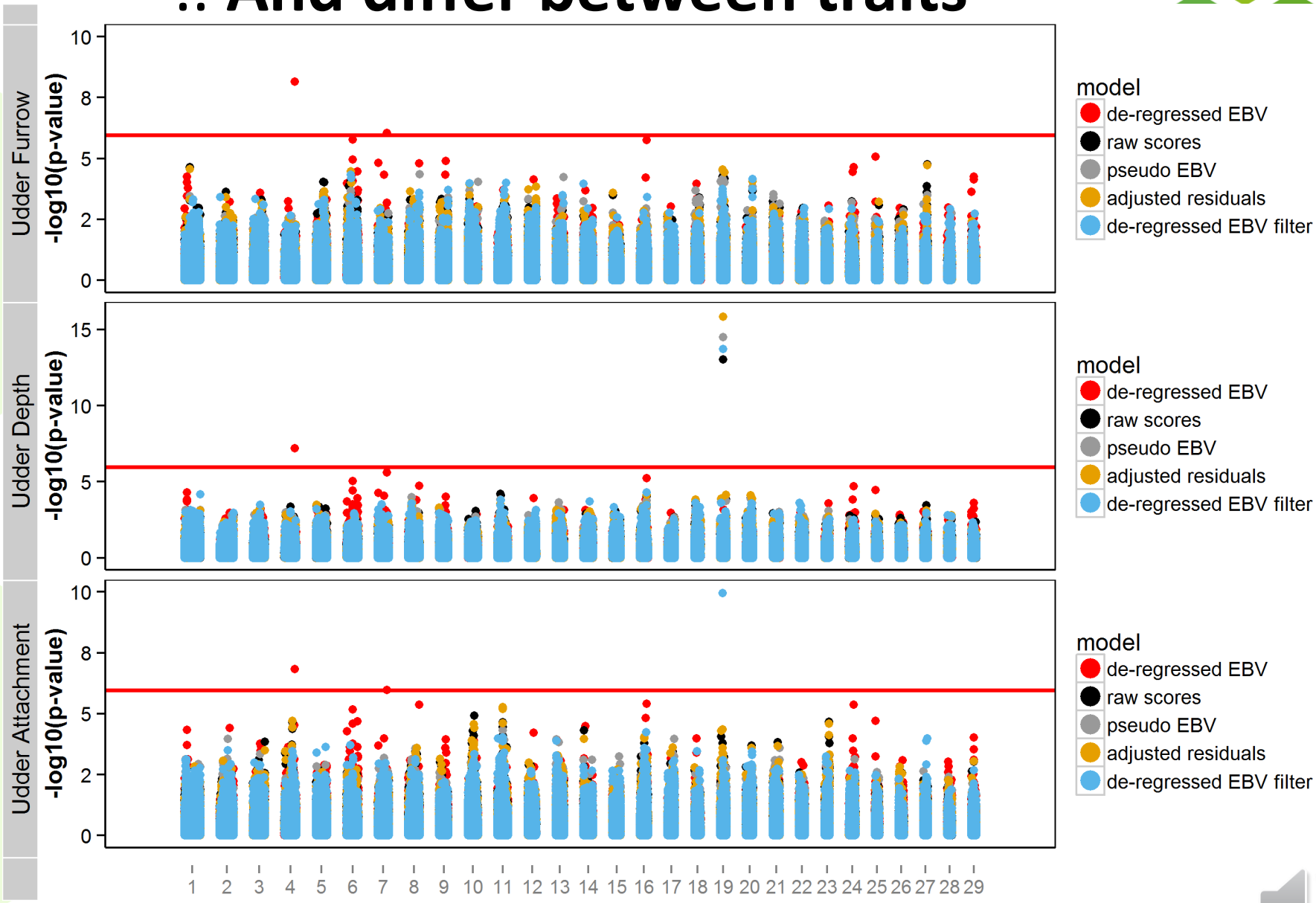
Differ between breeds…

Holstein **Dystocia** **Charolais**



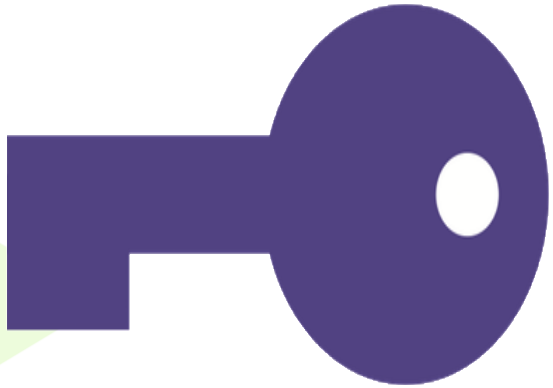
Purfield et al., (2014)

.. And differ between traits



Mucha, Mrode, Coffey, Kizilaslan, Desire, Conington J. 2018 J. Dairy Sci.101(3):2213-2225

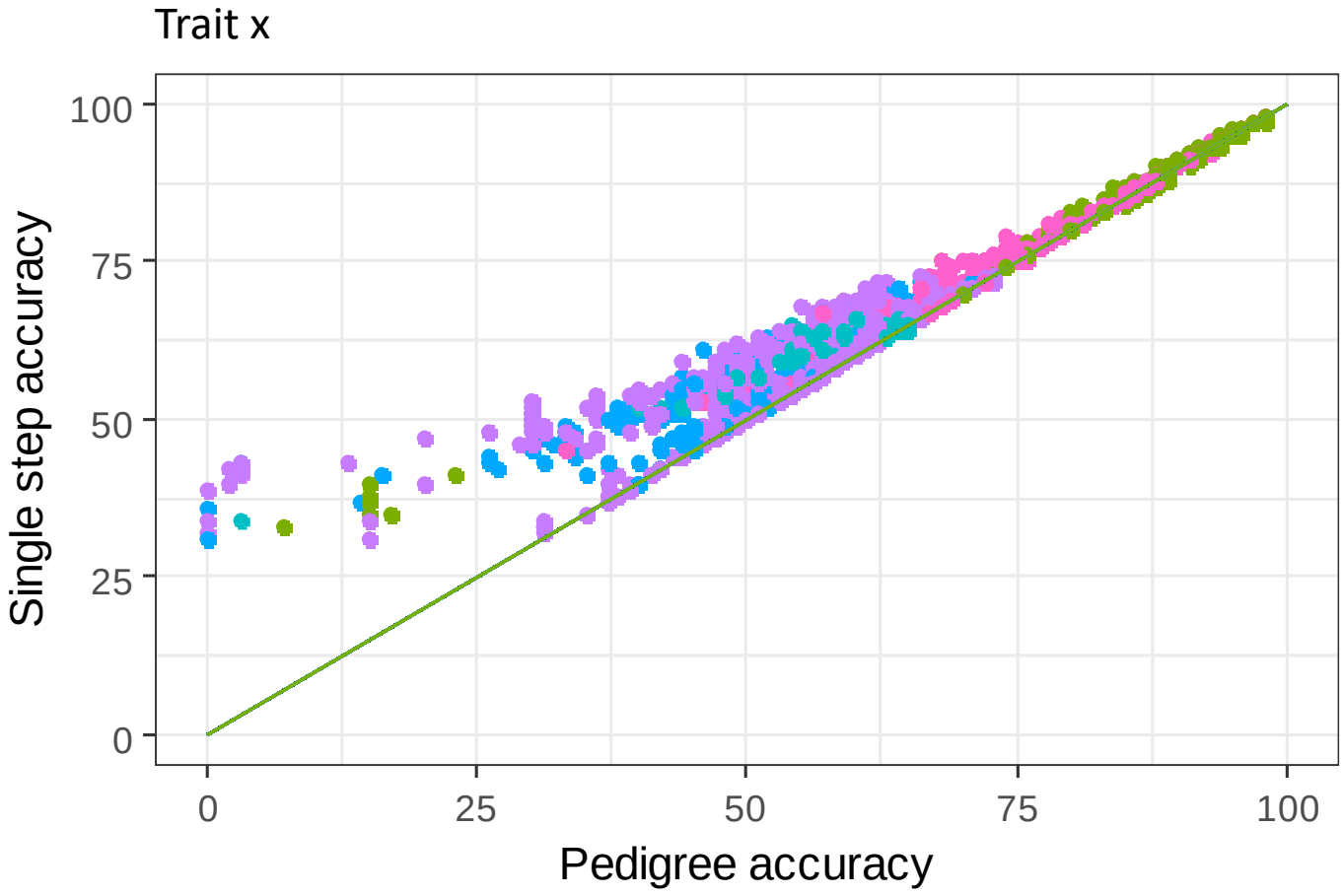
Linking phenotype to genotype



Genomic
Estimated
Breeding
Values

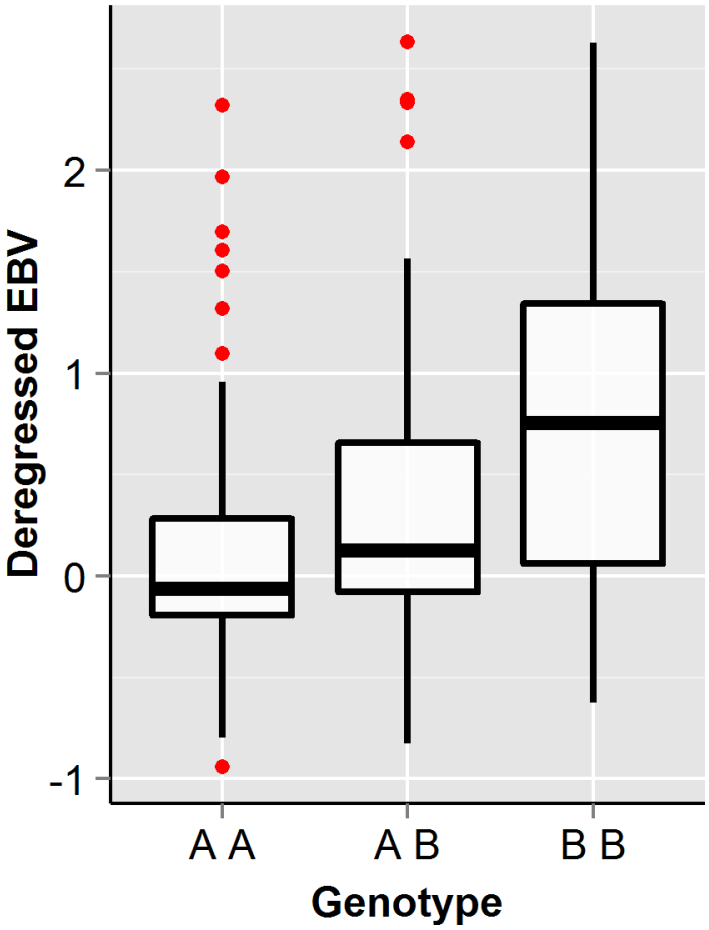
‘Genomically-enhanced’ breeding values

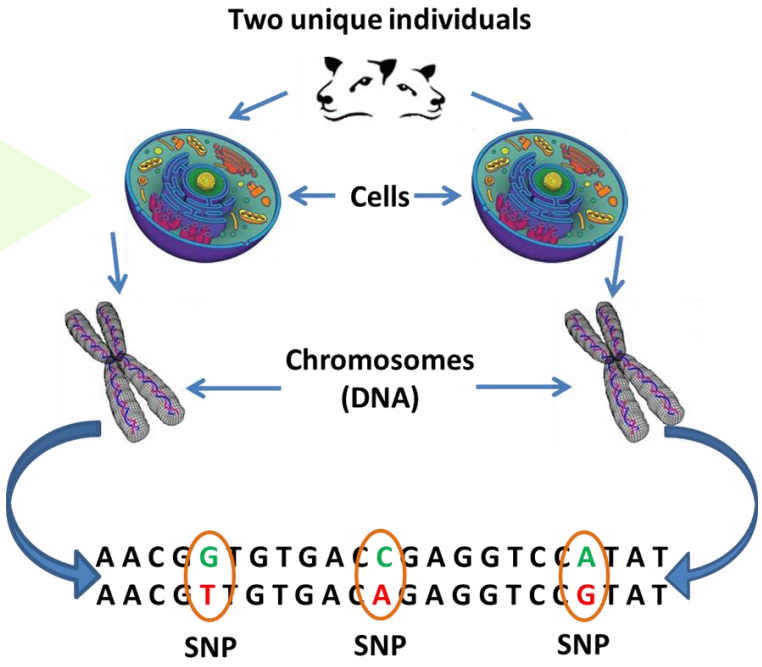
Genomic selection most beneficial when EBV accuracy is low



D. Brown, pers. comm 2018

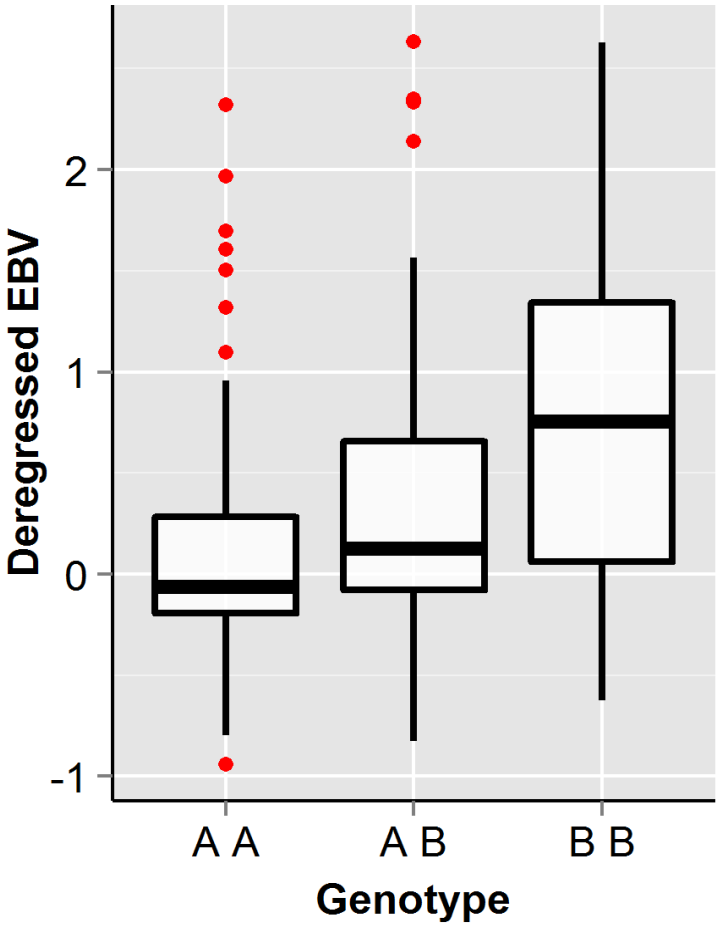
Value of using genomic selection

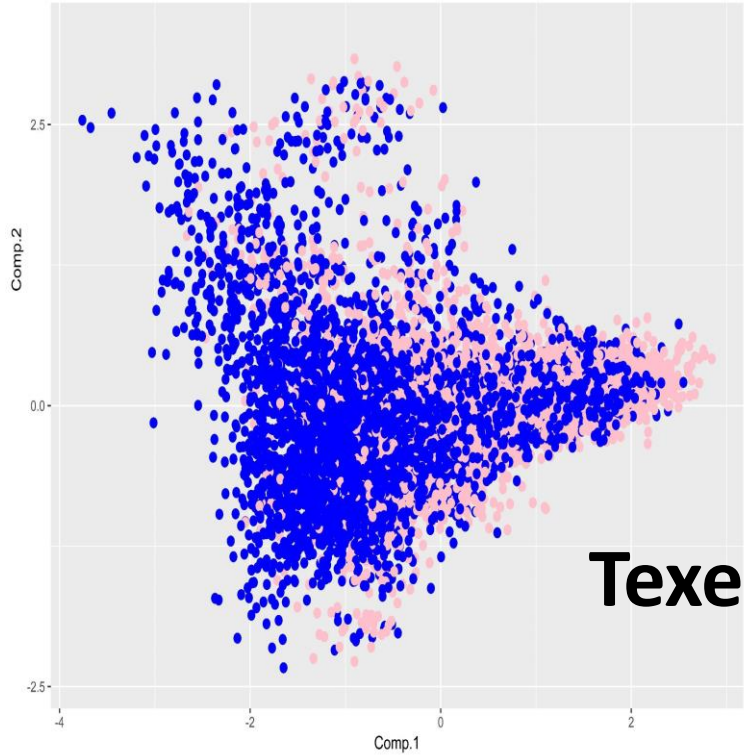




Example of SNP OAR2_198741802.1

Genomic selection linked to phenotype





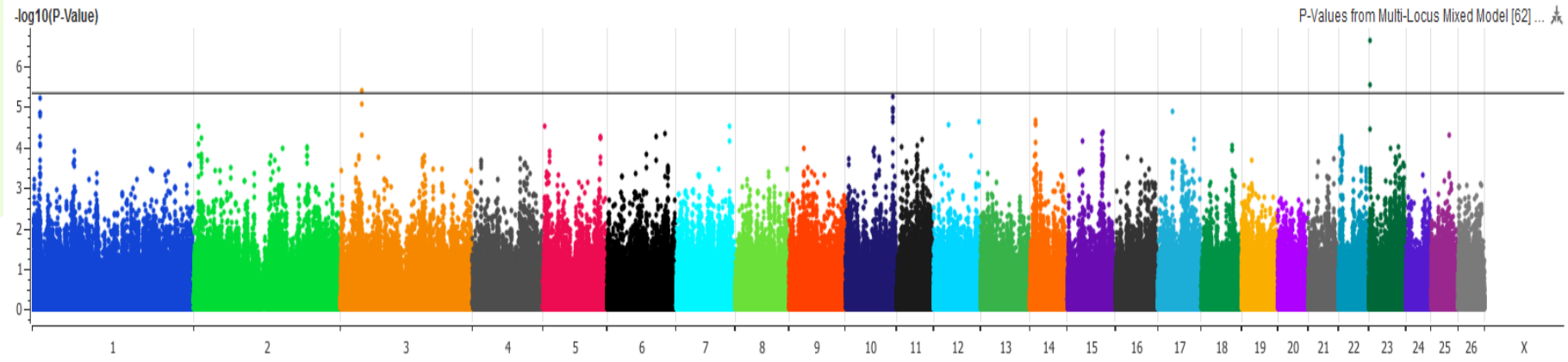
Texel PCA

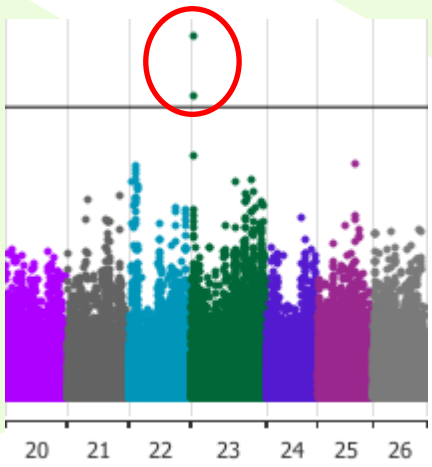
Kaseja 2019

Example of SNP OAR2_198741802.1

Looking for major genes

- Region of interest identified on Chromosome 23



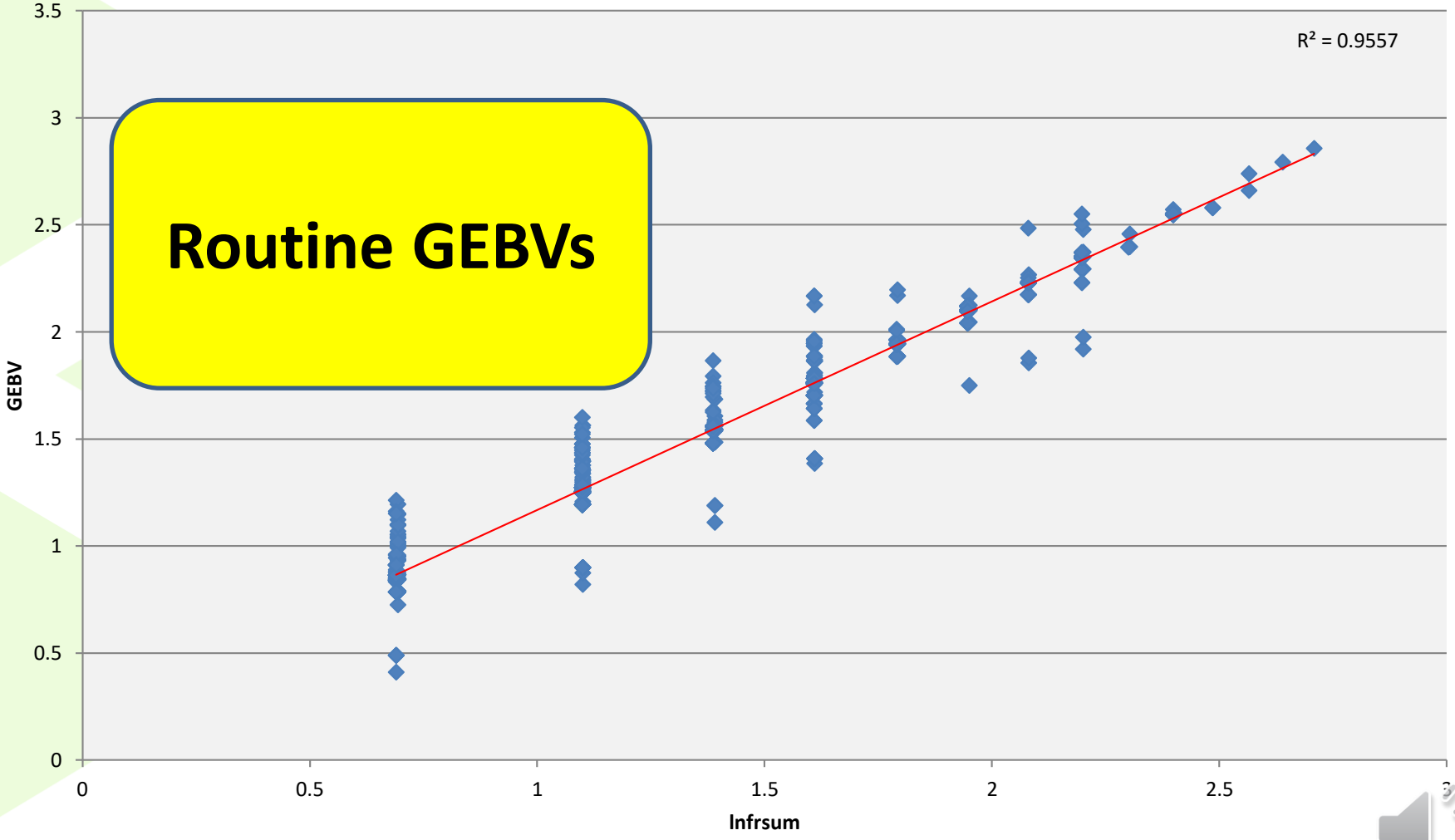


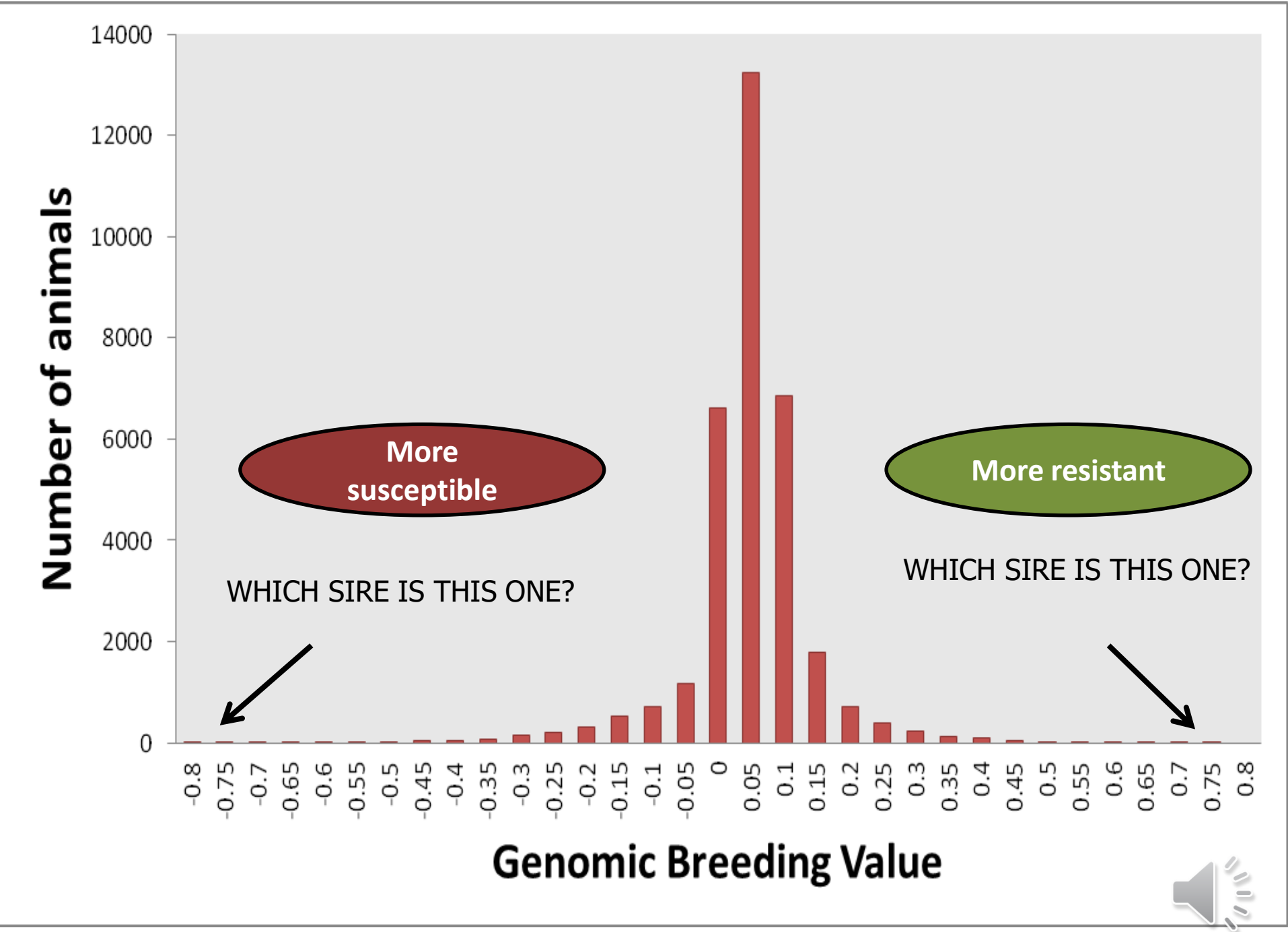
OAR23_2961089
OAR23_3237800

- 2,995 genotypes
- 422,532 SNPs

Footrot GEBV

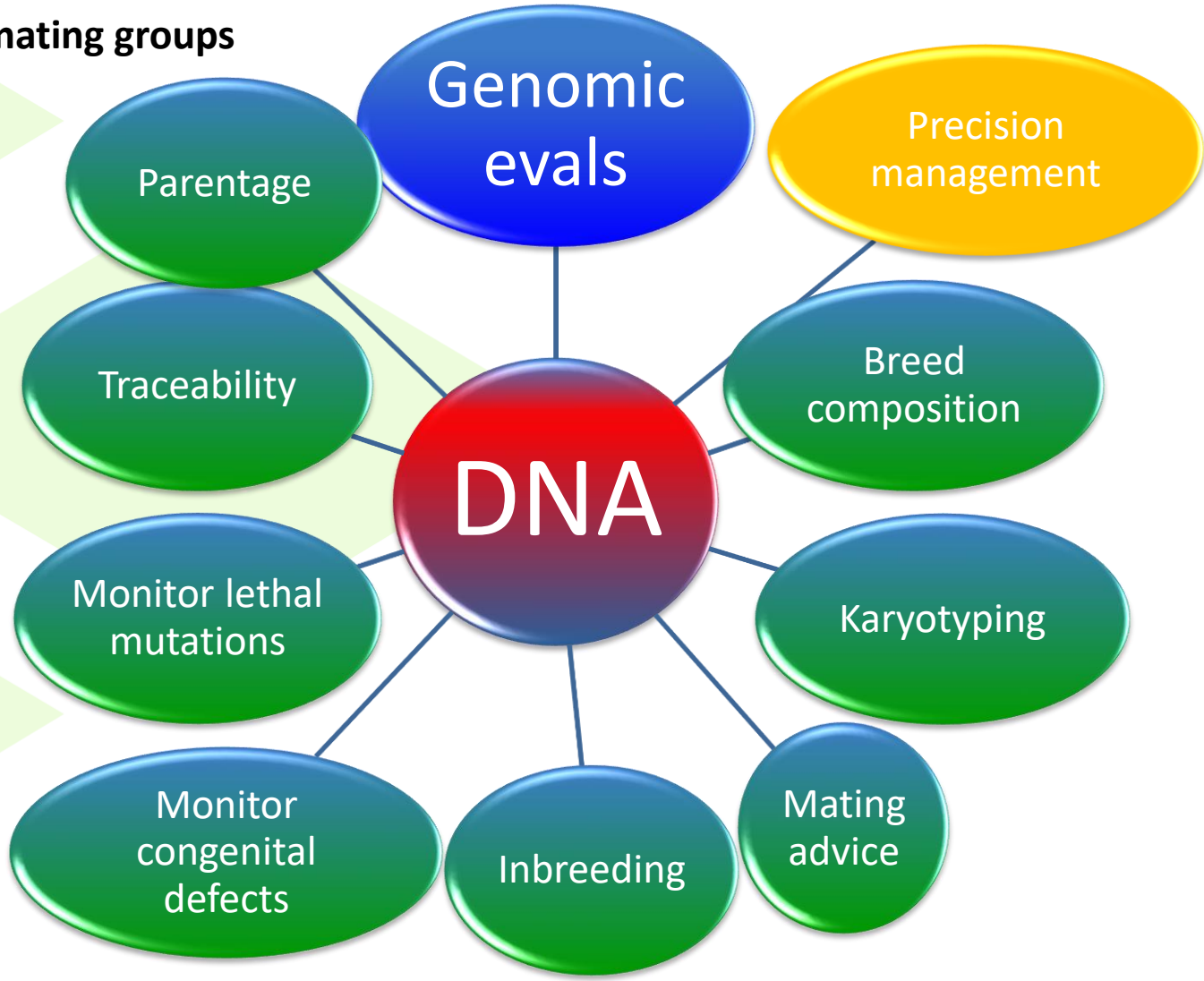
Correlation between GEBV and phenotype **0.98**




Number of animals
14000
12000
10000
8000
6000
4000
2000
0
More susceptible
More resistant
WHICH SIRE IS THIS ONE?
WHICH SIRE IS THIS ONE?
-0.8
-0.75
-0.7
-0.65
-0.6
-0.55
-0.5
-0.45
-0.4
-0.35
-0.3
-0.25
-0.2
-0.15
-0.1
-0.05
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5
0.55
0.6
0.65
0.7
0.75
0.8
Genomic Breeding Value

Additional benefits of using genomics

Multiple sire mating groups



Key points

Health traits

High prevalence

✓

Heritable

Eur7.13

Acknowledgements

TEXEL SHEEP SOCIETY

SRUC

Innovate UK
Technology Strategy Board

The Scottish Government

Smarter
SMAll RuminanTs breeding for Efficiency and Resilience

SRUC

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