

# ***Breeding Better Bones: Using genomics to improve bone health in laying hens***



WEBINAR SERIES  
**BREEDERS TALK GREEN**  
Tuesday 9 February 2021  
13:30 - 15:15 CET  
organised by  

The banner features five small images: a cow, a fly, a chicken, a landscape, and piglets.



***Genetic improvement of bone health at farm level will require evaluations at farm level, across systems***



# AVIAN OSTEOPOROSIS:

*Is a welfare issue. Whilst > 90% of processed hens have at least one fracture... (Gregory & Wilkins 1989)*



*... a large proportion of fractures occur even before depopulation:*

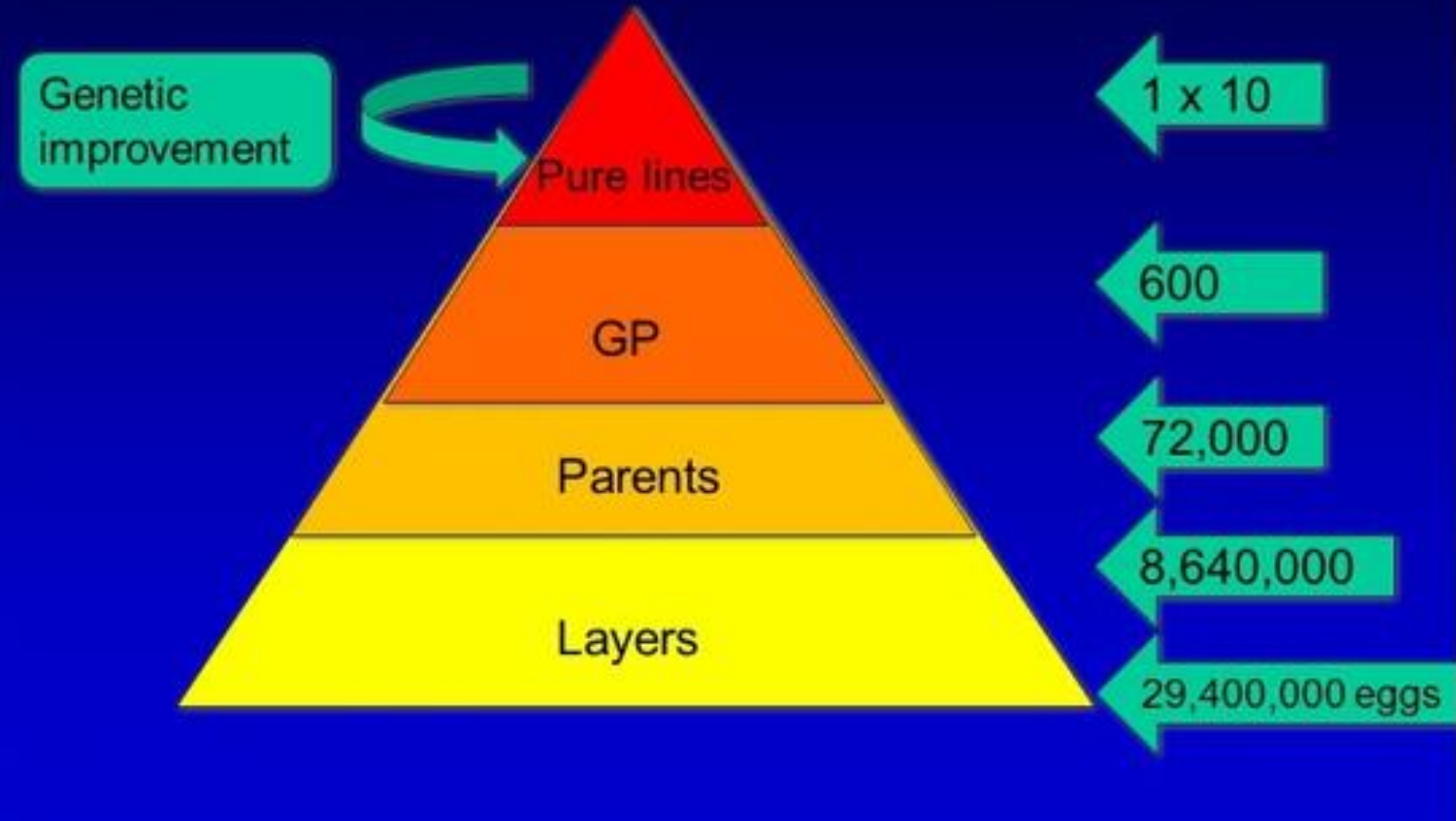
<b>System</b>	<b>Fractures %</b>
<b>Barn.....</b>	<b>42%</b>
<b>Cages.....</b>	<b>25%</b>
<b>Enriched cage....</b>	<b>35%</b>
<b>Free range.....</b>	<b>34 to 71%</b>

*(Wilson et al, pers. comm., 2004)*

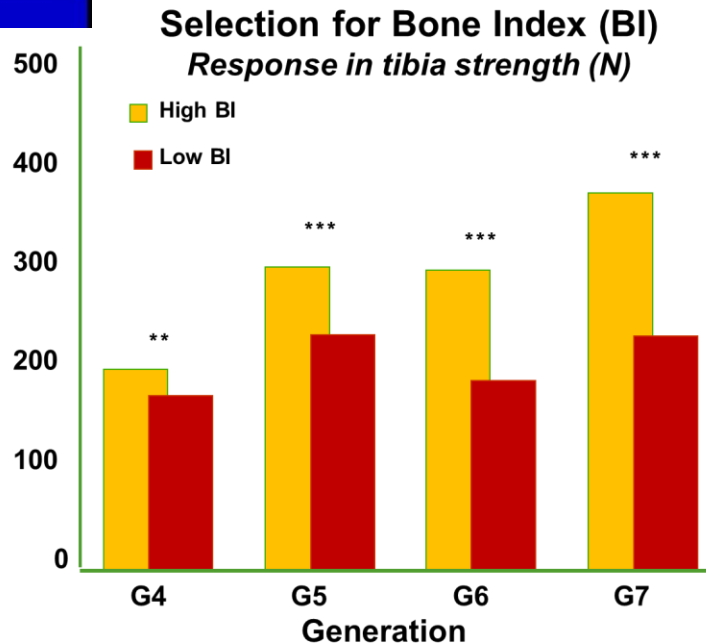
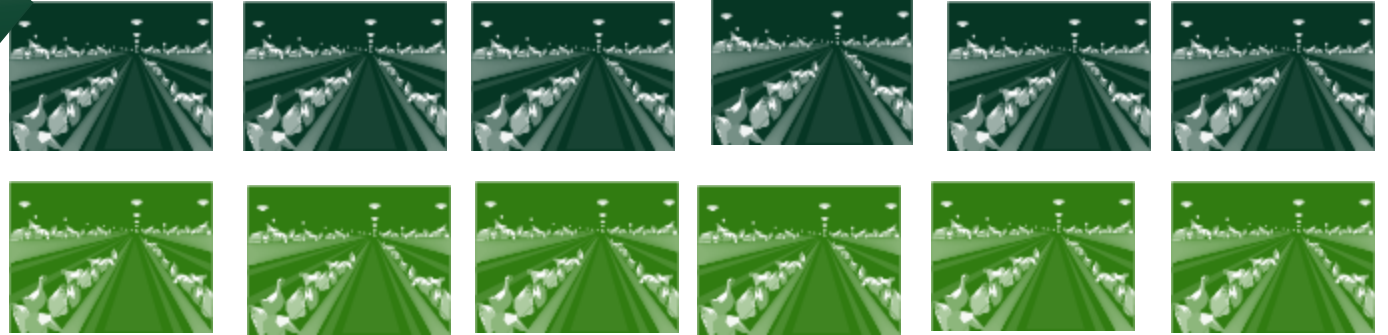
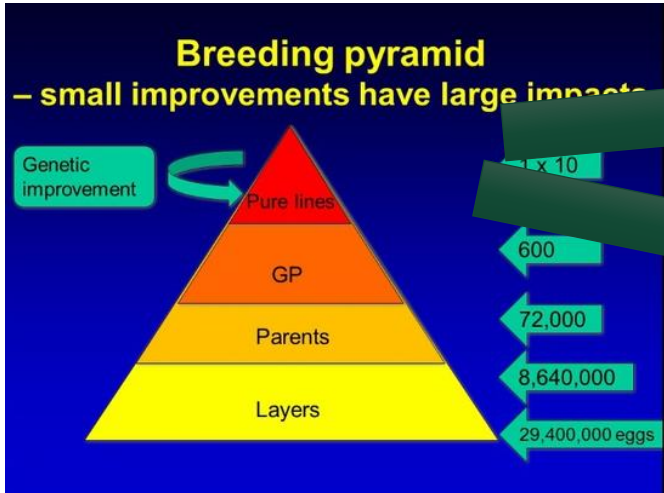
**EU-27 flock 2011 = 363 million hens**

# Breeding pyramid

– small improvements have large impacts

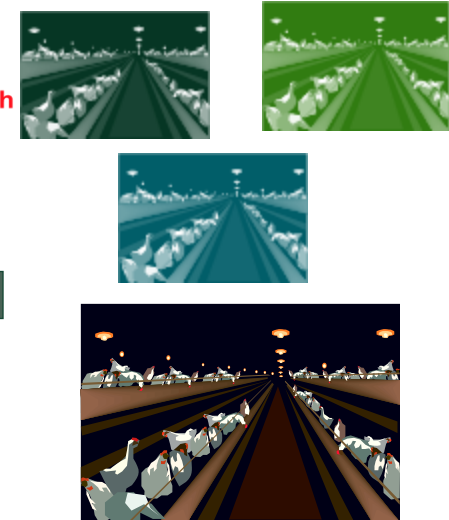
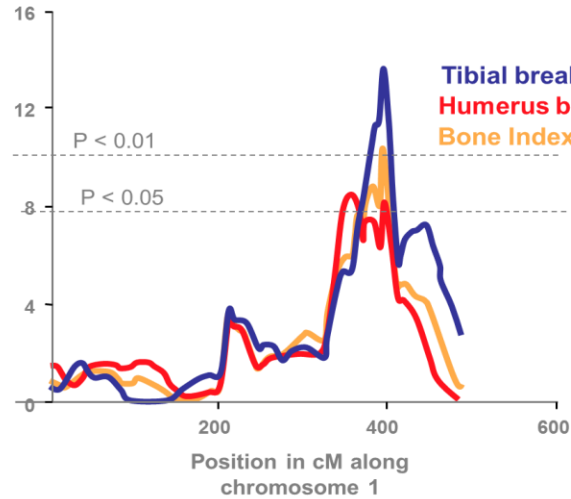
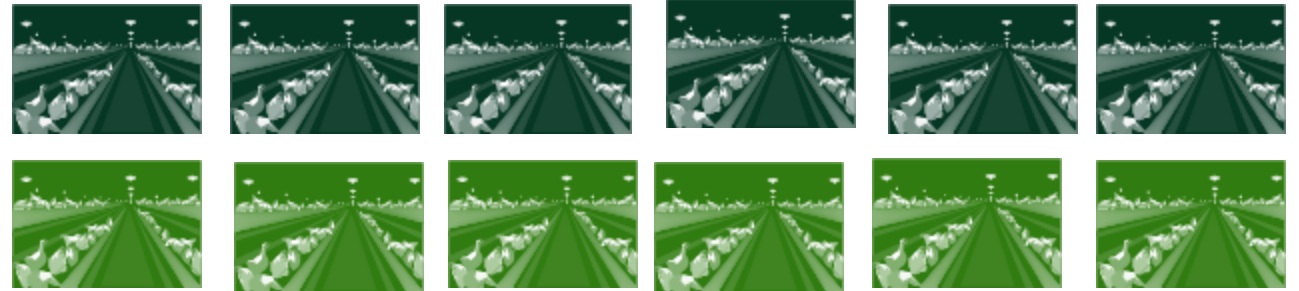
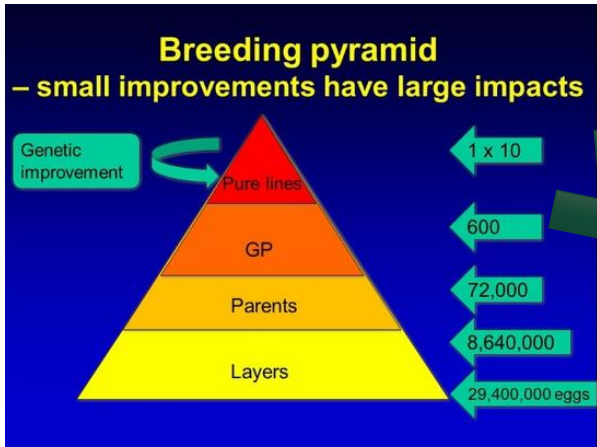


# Bone strength studies in layers: Selection lines



Bishop et al. British Poultry Science, 2000. 41(1): p. 33-40.

# Bone strength studies in layers: QTL



De Koning et al. *Genet Sel Evol* (2020) 52:13  
<https://doi.org/10.1186/s12711-020-00532-y>

**GSE** Genetics Selection Evolution

RESEARCH ARTICLE

Open Access



## An eQTL in the *cystathionine beta synthase* gene is linked to osteoporosis in laying hens

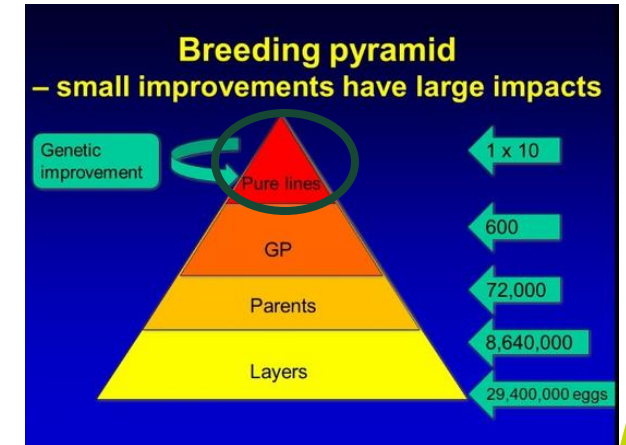
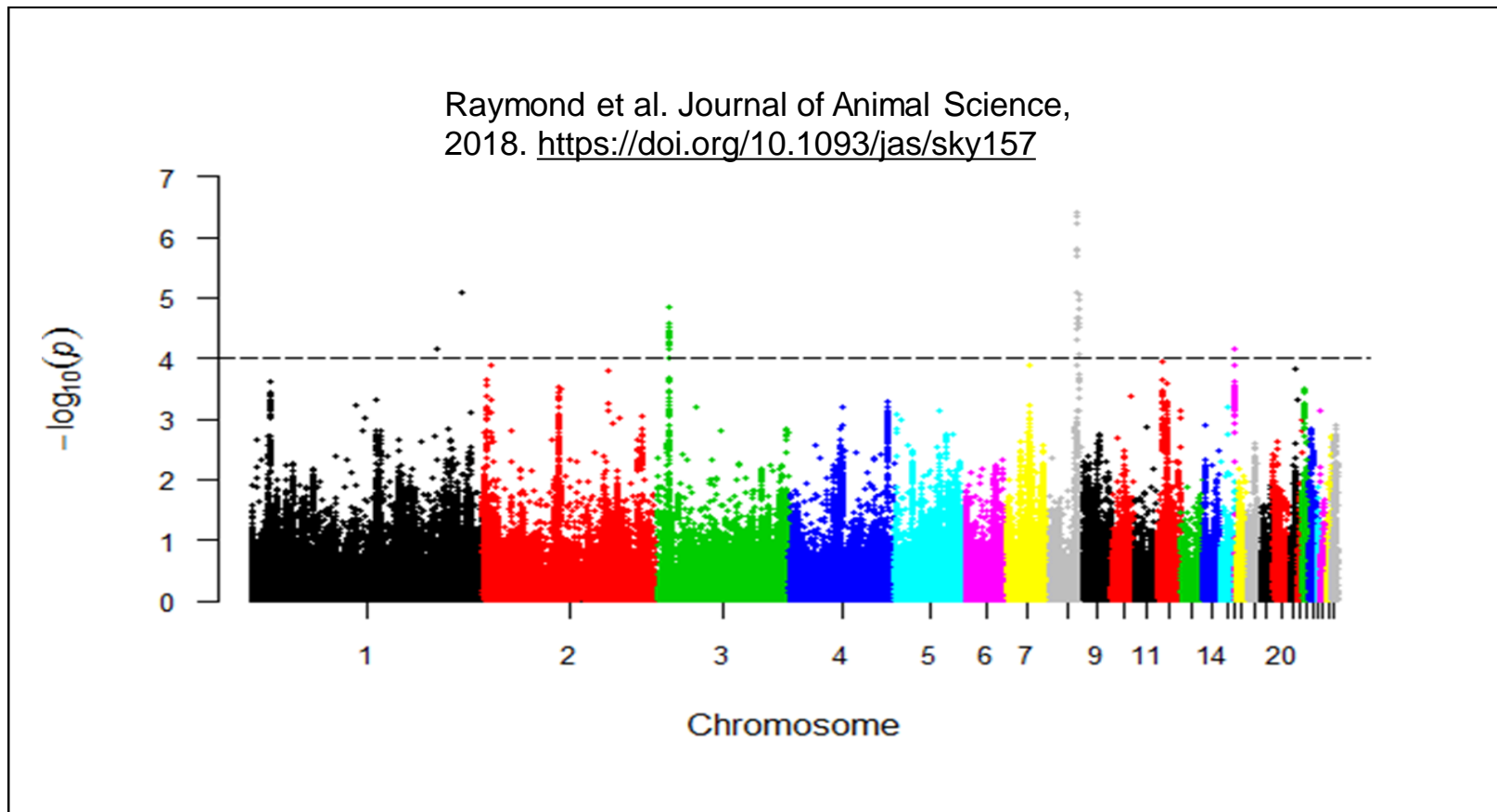
Dirk-Jan De Koning<sup>1</sup>, Nazaret Dominguez-Gasca<sup>2</sup>, Robert H. Fleming<sup>3</sup>, Andrew Gill<sup>3,7</sup>, Dominic Kurian<sup>3</sup>, Andrew Law<sup>3</sup>, Heather A. McCormack<sup>3</sup>, David Morrice<sup>3</sup>, Estefania Sanchez-Rodriguez<sup>2</sup>, Alejandro B. Rodriguez-Navarro<sup>2</sup>, Rudolf Preisinger<sup>4</sup>, Matthias Schmutz<sup>4</sup>, Veronica Šmidová<sup>3,6</sup>, Frances Turner<sup>3</sup>, Peter W. Wilson<sup>3</sup>, Rongyan Zhou<sup>3,5</sup> and Ian C. Dunn<sup>3\*</sup>

Dunn et al. *Animal Genetics*, 2007. **38**(1): p. 45-49.



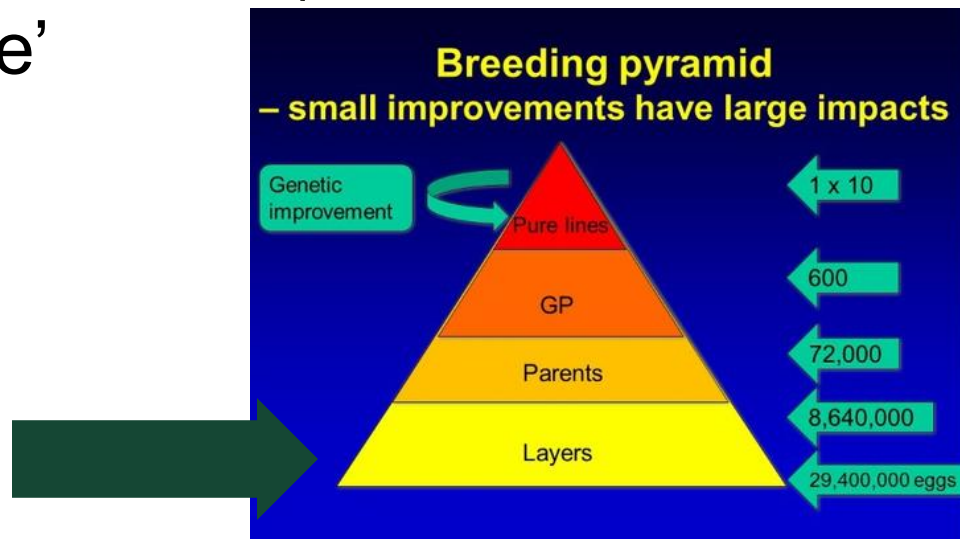
# Finding genome regions that affect bone strength (GWAS)

- 752 birds from ~2000 top and tail (breeding lines)



# So you found some QTL? What next?

- Research Questions:
  - Do significant SNPs from elite lines have *any meaning* in **commercial layers ? (2 breeds)**
  - Effect of housing regime (enriched cages & floor pens)
  - Effect of diet supplementation (organic zinc)
  - Pleiotropic effects on 'feather score'

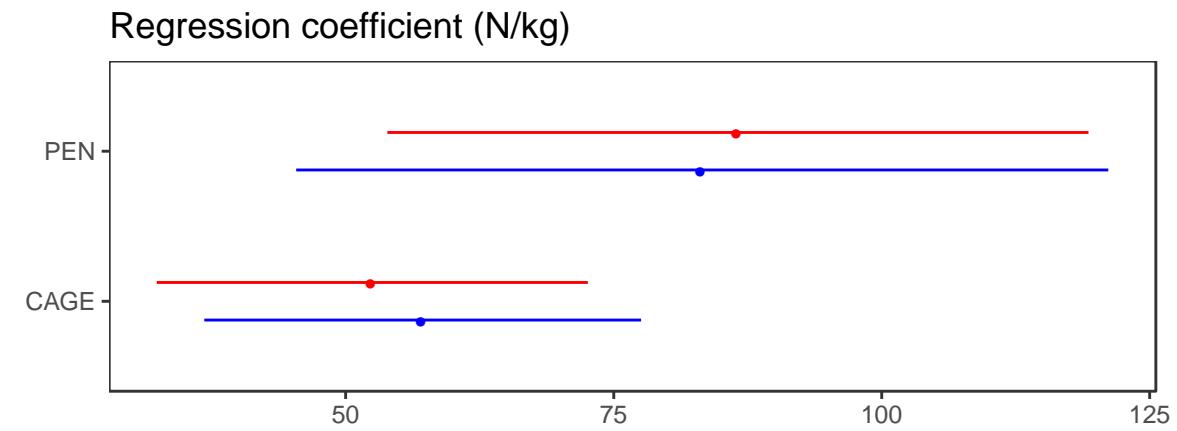
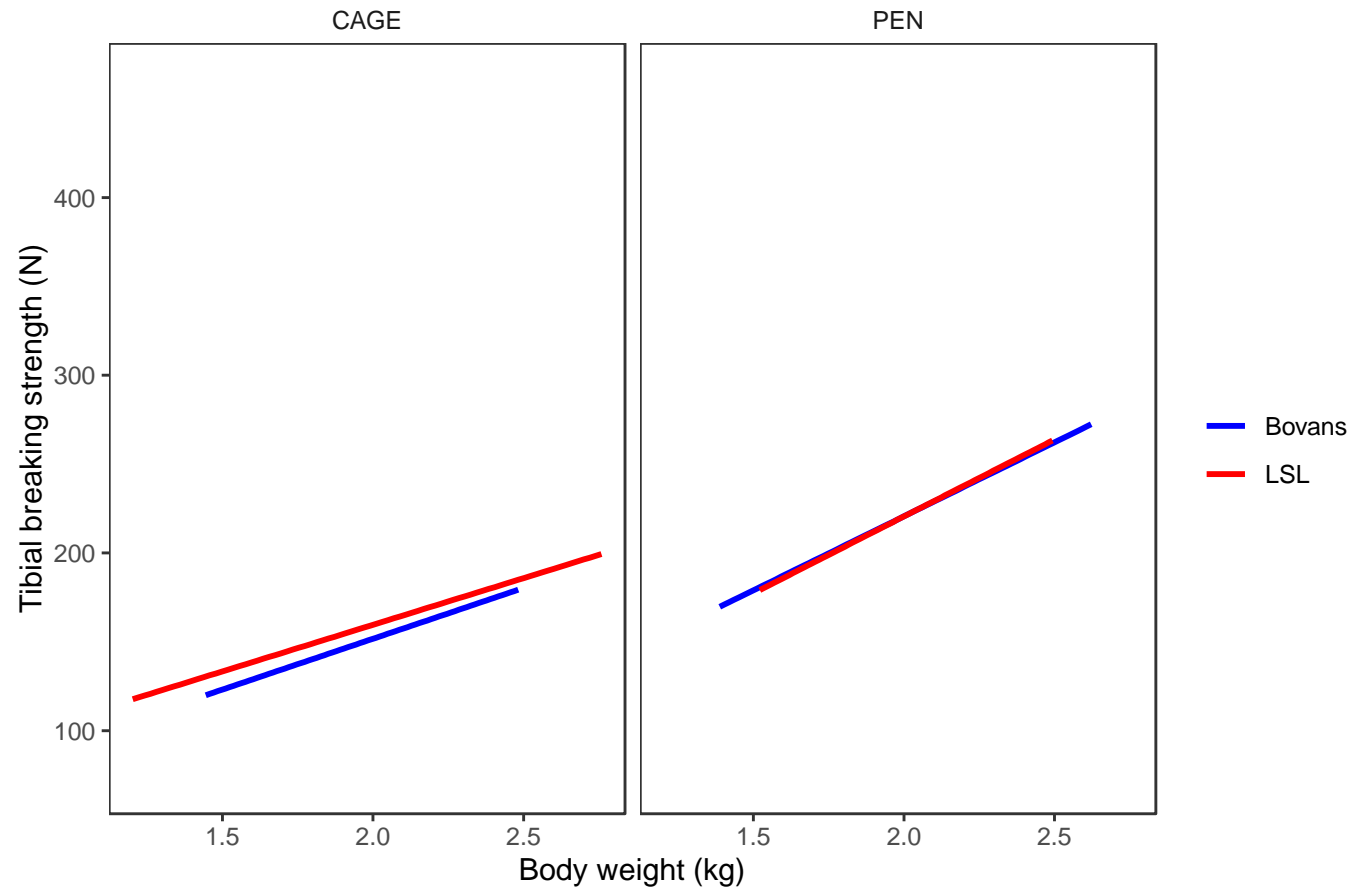




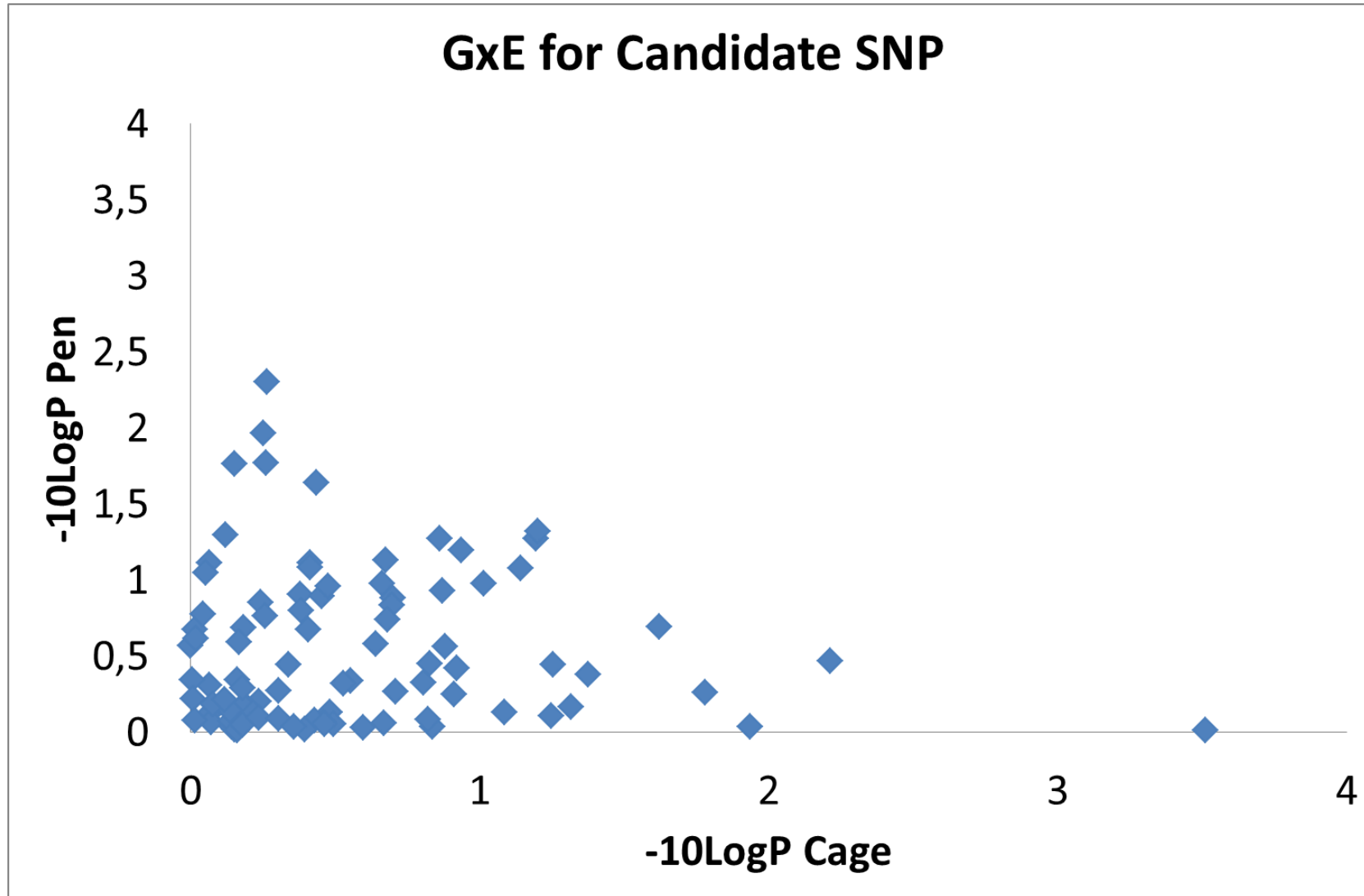
# Layer experiment

- ~1000 birds dissected at end-of-lay (100 weeks)
- Checked whether still in lay
- 111 SNP selected from GWAS and literature
  - Common SNP set across "Better Bones" populations
  - Assay by LGC
- Whole genome
  - 25K Illumina SNP chip
  - Genotyping by SciLife Lab Uppsala



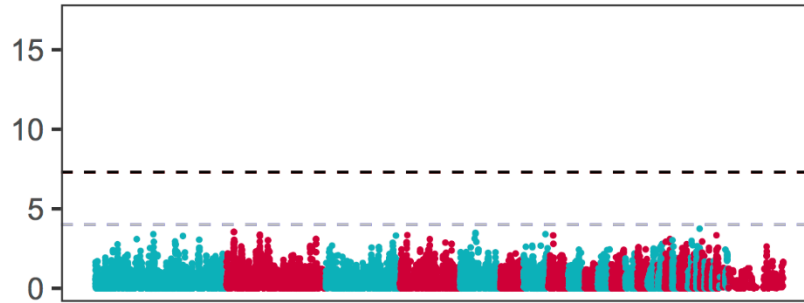


# QTL do not act universal

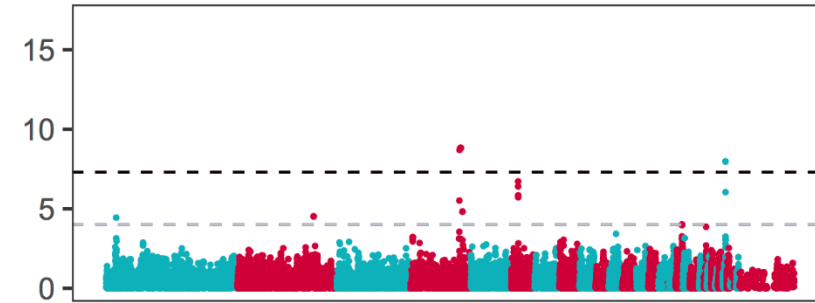




Bone breaking strength (CAGE)

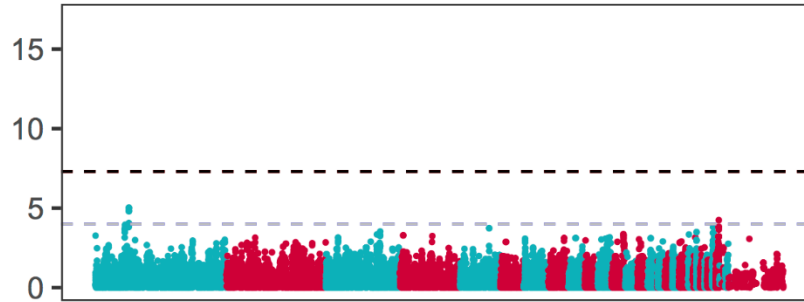


Body weight (CAGE)

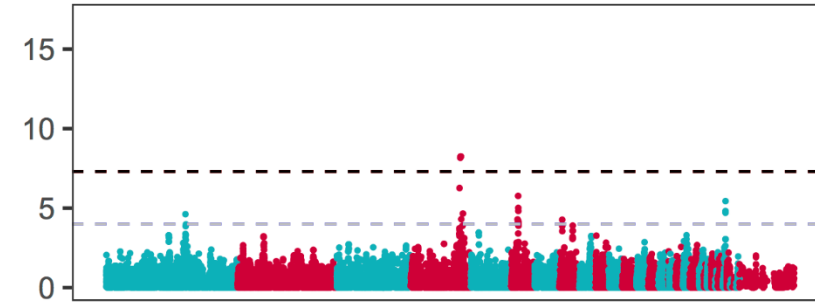


Negative logarithm of p-value

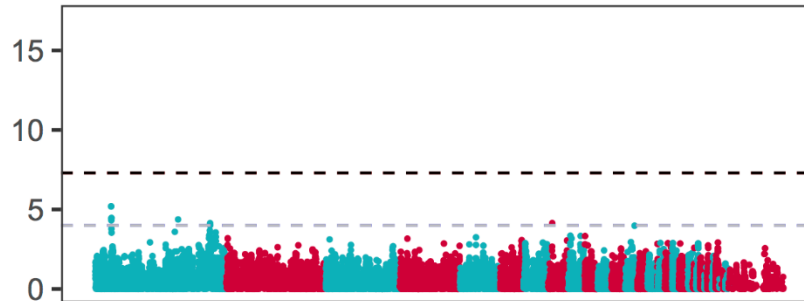
Bone breaking strength (PEN)



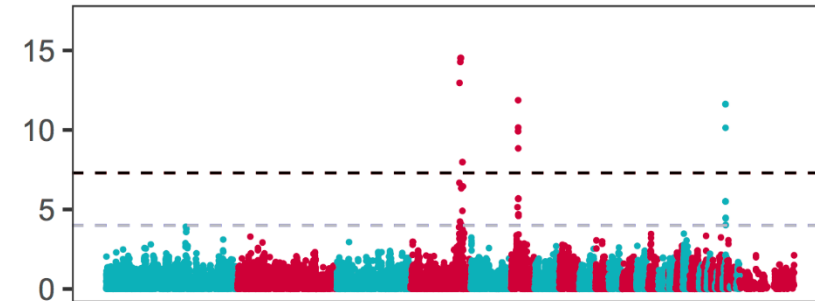
Body weight (PEN)



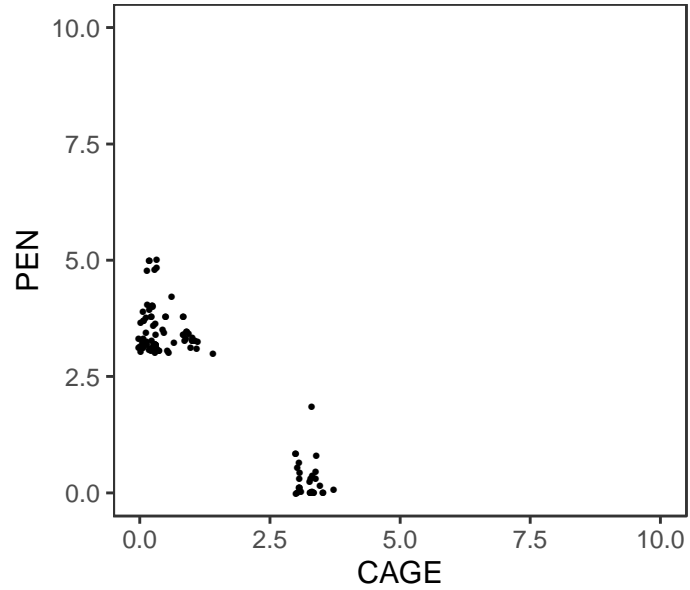
Bone breaking strength (JOINT)



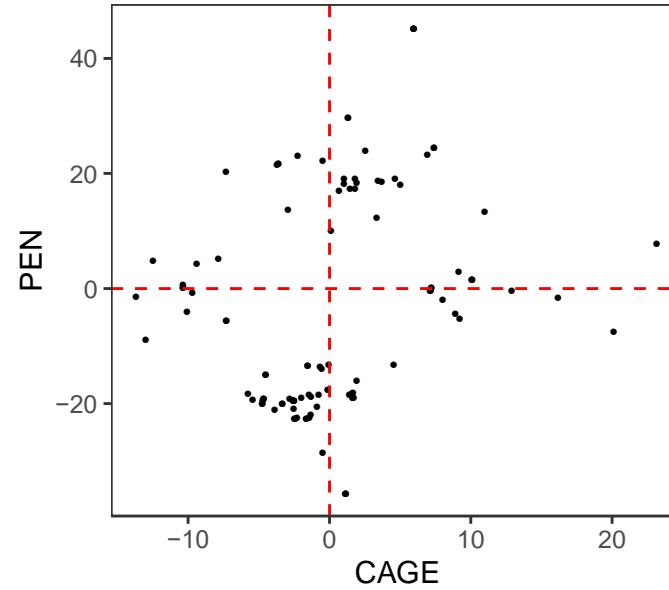
Body weight (JOINT)



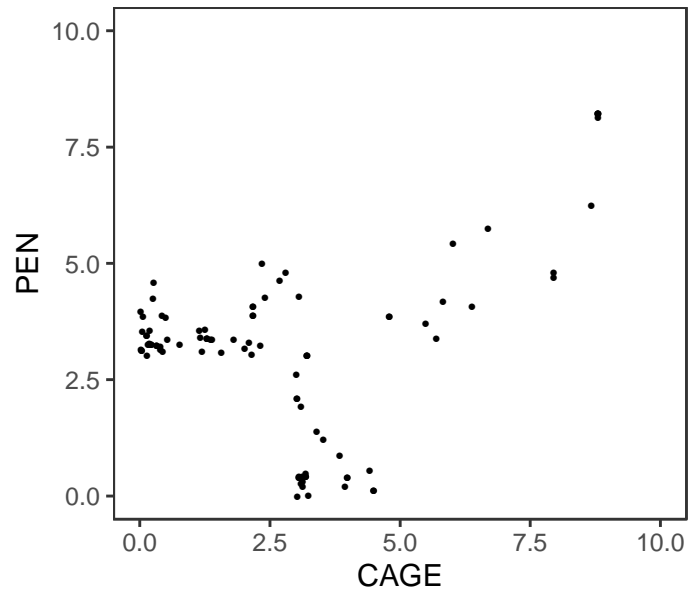
Tibial breaking strength  
Negative logarithm of p-value



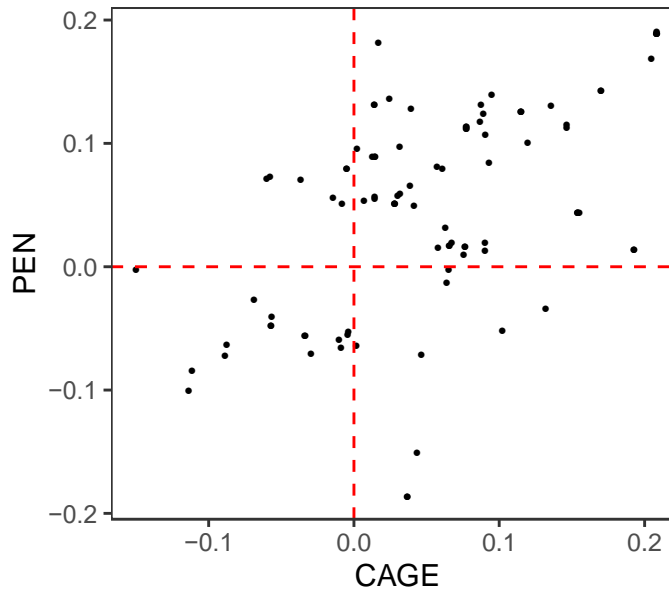
Tibial breaking strength  
Estimated marker effect



Body weight  
Negative logarithm of p-value



Body weight  
Estimated marker effect





# New Project: KeelBoneTools

Funded by Formas



# Keel Bone Damage major part of bone health

- Why did we study tibia?
  - ⇒ More straightforward to phenotype
  - ⇒ Good heritabilities (Ian Dunn)
  - ⇒ Expect high genetic correlations KBD...
- Looking for a 'high throughput' phenotype for Keel Bone!

# X-ray to rescue

- Developed within the keelbonedamage.eu consortium!
- Implemented by Ian Dunn in US funded project (FFAR)



METHODS  
published: 07 June 2018  
doi: 10.3389/fvets.2018.00124

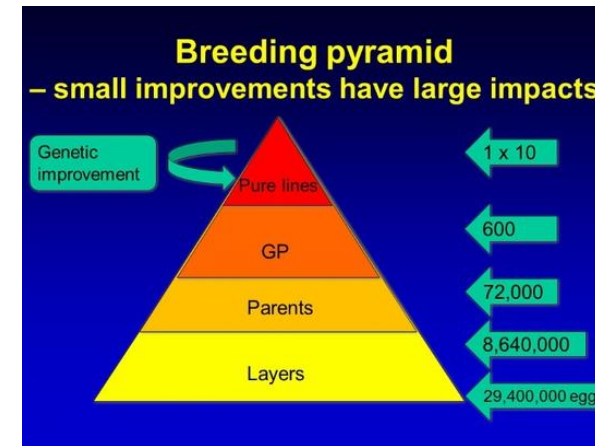
## A Reliable Method to Assess Keel Bone Fractures in Laying Hens From Radiographs Using a Tagged Visual Analogue Scale

*Christina Rufener<sup>1\*</sup>, Sarah Baur<sup>2</sup>, Ariane Stratmann<sup>1</sup> and Michael J. Toscano<sup>1</sup>*



## Project

- FFAR breeding lines (Ian Dunn)
- Commercial farm in Sweden
- Would like to introduce X-ray at farm level in Sweden
  - Monitoring
  - Crossbred information for purebred selection
  - Automated scoring of X-rays?



***Genetic improvement of bone health at farm level will require evaluations at farm level across systems***



# Researchers and Funding

- SLU
  - Helena Wall
  - Anna Johansson
  - Biaty Raymond
  - Fernando Lopes-Pinto
  - Marin Johnsson
- Roslin Institute, University of Edinburgh
  - Heather McCormack
  - Bob Fleming
  - Ian Dunn
- Uppsala University
  - Andreas Kindmark
- Universidad de Granada
  - Alejandro Rodriguez Navarro
- Lohmann Tierzucht
  - Rudolf Preisinger
  - Mattias Schütz
- KeelBoneDamage.eu.

COST Action CA15224