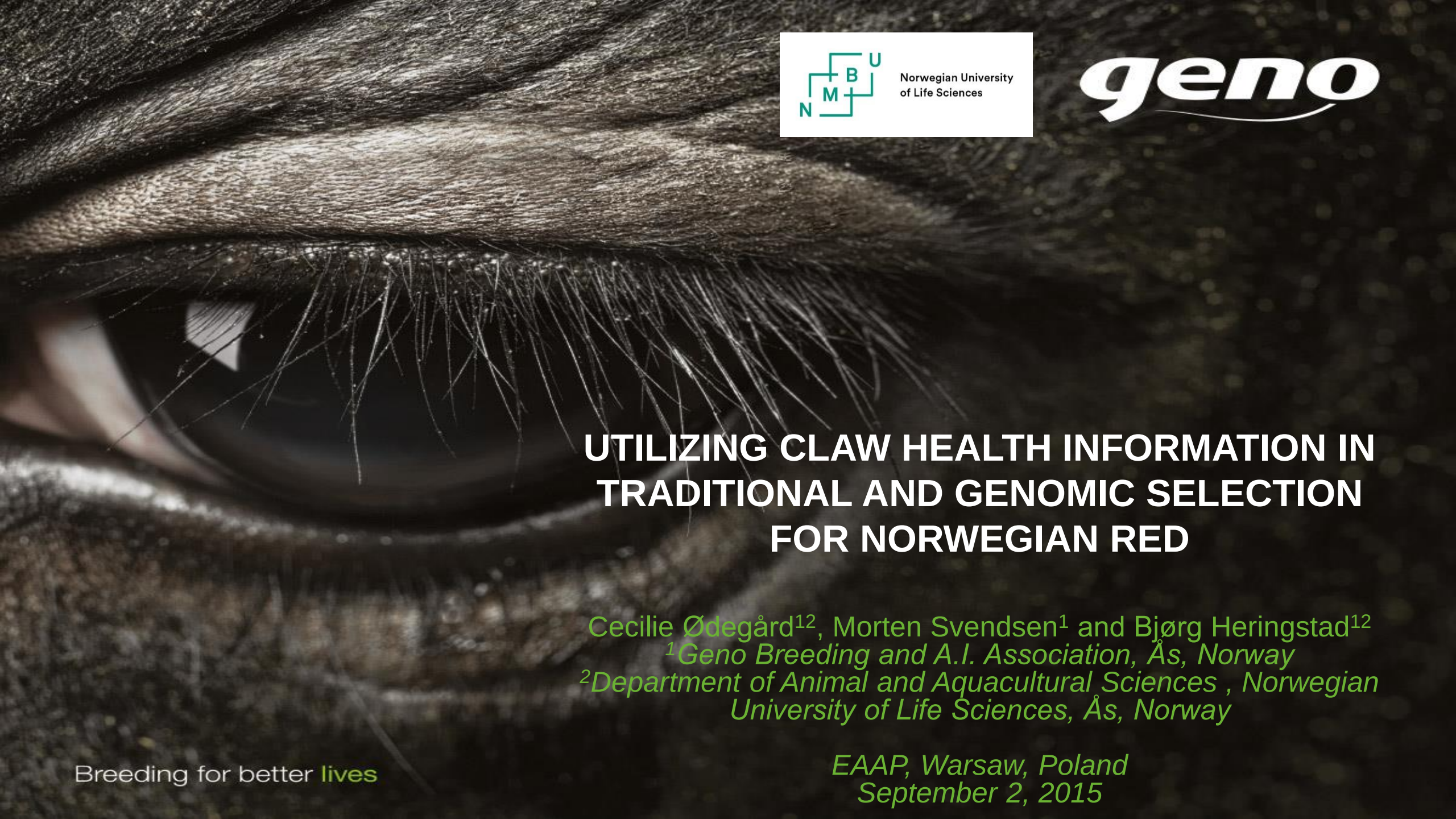

UTILIZING CLAW HEALTH INFORMATION IN TRADITIONAL AND GENOMIC SELECTION FOR NORWEGIAN RED

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Breeding for better lives

CLAW HEALTH

- Important for farmers economy and animal welfare

- Recorded at claw trimming since 2004 to the Norwegian Dairy Herd Recording System

AIM:

Genetic analyses of claw disorders recorded at claw trimming, to find an efficient breeding strategy for improved claw health in Norwegian Red cows

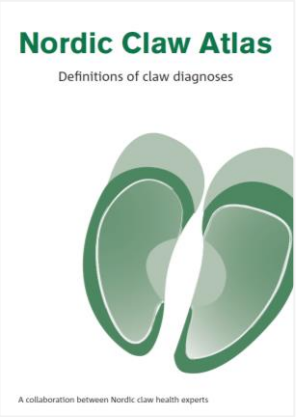
CLAW HEALTH RECORDING

- Date of claw trimming
- ID of animal
- Normal claws or one or more claw disorders
- Other disorders or remarks
- Claw trimmer ID

➢ Electronic recording of claw health
  – Terminals sent to 20 professional claw trimmers

HARMONIZATION OF CLAW DISORDERS

- Denmark, Finland and Sweden
  - Due to implementation of electronic recording
  - 19 claw disorders



- ICAR Claw Health Atlas
  - International standard
  - 23 claw disorders
  - http://www.icar.org/Documents/ICAR_Claw_Health_Atlas.pdf

CLAW DISORDERS

Corkscrew claw

- Corkscrew claw
- Dermatitis
- Heel horn erosion
- Interdigital phlegmon

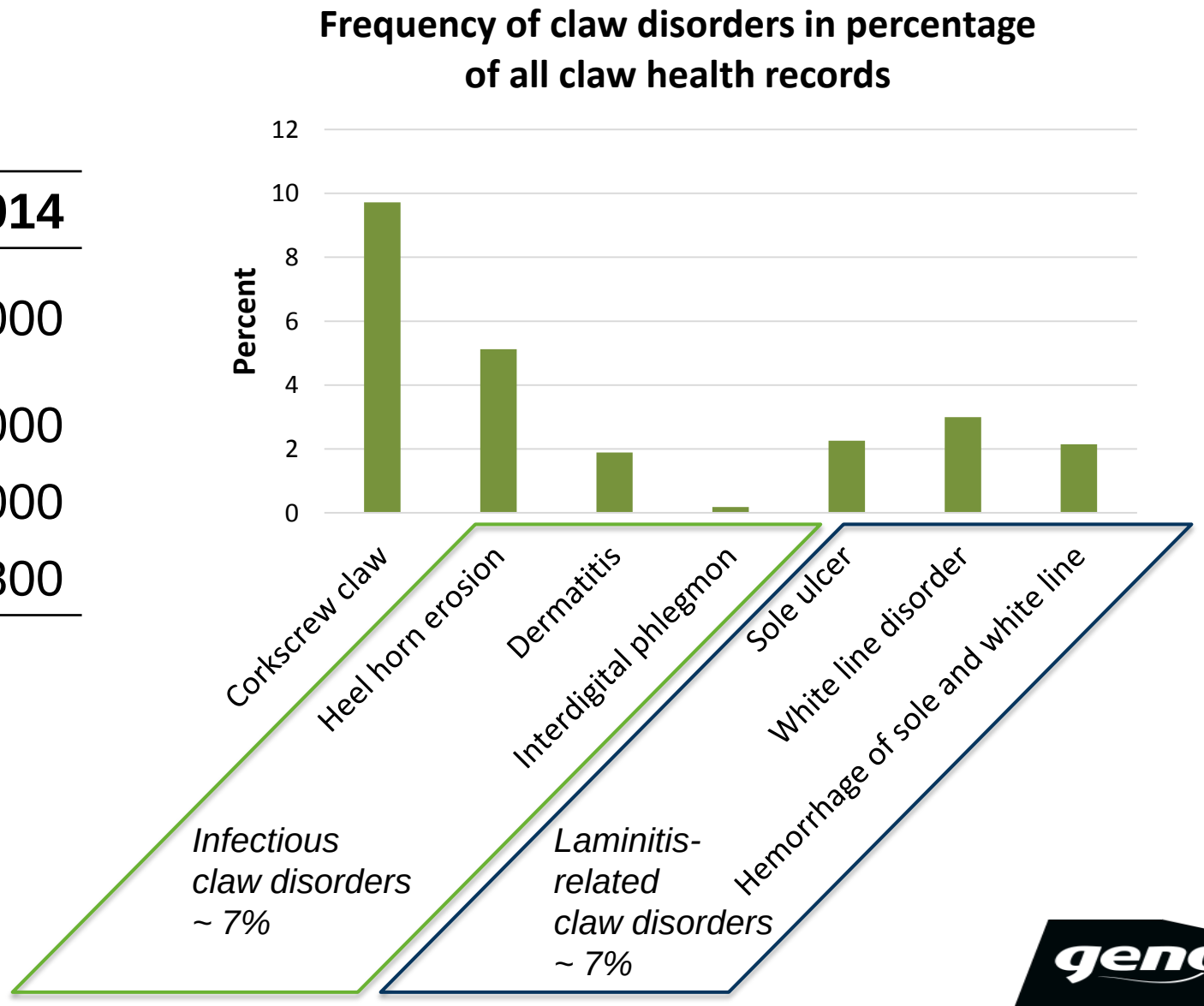
Infectious claw disorders

- Sole ulcer
- White line disorder
- Hemorrhage of sole and white line

Laminitis-related claw disorders

DATA 2004-2014

	Total	2014
Claw health records	550,000	85,000
Cows	280,000	65,000
Herds	6,900	3,000
Sires	3,500	1,800



EDITING OF DATA

- Lactating cows with claw health records
- Herds with less than 10% or less than 10 normal claws reported during 2004 to September 2013 were excluded
- Daughters of Norwegian Red AI sires
- At least one claw trimming record in the parity

Trait definition:

In each parity a cow was defined as unaffected (0) or affected (1) for the single claw disorders and the groups of claw disorders

MODEL

- Threshold sire model – estimation of genetic parameters
- Linear animal model – prediction of breeding values

  - Fixed effects:
    - Lactation number
    - Calving year and month
    - Time for claw trimming (months after calving)
    - Claw trimmer
    - Housing system (animal model only)

  - Random effects:
    - Herd
    - Permanent environment (animal model only)
    - Sire/Animal
    - Residual

GENETIC PARAMETERS OF CLAW DISORDERS
(FROM MULTIVARIATE THRESHOLD MODELS)

Claw disorder	Heritability
Corkscrew claw (CSC)	0.22
Heel horn erosion (HH)	0.08
Dermatitis (DE)	0.18
Sole ulcer (SU)	0.16
White line disorder	0.05
Infectious claw disorder	0.10
Laminitis-related claw disorder	0.10

- Genetic correlations between claw disorders and foot and leg conformation traits ranged from -0.86 to 0.26

Ødegård et al., 2013 JDS 96:7274-7283; Ødegård et al., 2014 JDS 97:4522-4529

CLAW HEALTH INDEX

- 4% weight in the total merit index for Norwegian Red
- Implemented 2014

Claw disorder	**Weight %**
Corkscrew claw	50
Infectious claw disorders	30
Laminitis-related claw disorders	20

GENOMIC SELECTION AND CLAW HEALTH

- Results from GBLUP showed low predictive correlations of GEBV
  - Novel traits with limited historical data
  - Low heritabilities
  - Small daughter groups per sire

Ødegård et al., 2015 JDS 98:4139-4147

- **AIM: Evaluate whether use of single-step GBLUP (ssGBLUP) and inclusion of both sire and cow genotypes improve genomic predictions of claw disorders.**

TRAITS

- Corkscrew claw, infectious claw disorders and laminitis-related claw disorders
  - 318,349 claw health records from 206,533 cows and 6,303 herds

SNP DATA

- Customized 54K Affymetrix SNP-chip
  - 54,574 SNP
  - 1,726 genotyped cows with claw health records of 2,037 genotyped sires

ANALYSES

- 10-fold cross-validation
  - 1,202 sires (>30 daughters with claw health records) were randomly assign to 10 groups

SINGLE-STEP GBLUP

- Three relationship matrices:
  1. A-matrix (pedigree information only)
  2. A-matrix and genotypes of sires combined to H-matrix
  3. A-matrix and genotypes of sires and cows combined to H-matrix

Correlation between:

EBV from validation sets* and EBV from full dataset**

*EBV from BLUP or ssGBLUP, dataset where phenotypes of daughters of validationbulls left out

**Full dataset using ssGBLUP, H-matrix including pedigree and genotypes of sires and cows

RESULTS
(CORRELATION BETWEEN EBV FROM VALIDATION DATA AND FULL DATASET)

Corkscrew claw

	BLUP
Mean	0.67 (0.04)

Infectious claw disorder

	BLUP
Mean	0.67 (0.04)

Laminitis-related claw disorder

	BLUP
Mean	0.68 (0.05)

HOW TO IMPROVE GENOMIC PREDICTIONS OF CLAW HEALTH?

- Increase number and quality of phenotypic records
- Increase number of available genotypes (both sires and cows)
- Improvement of methods and models

Dermatitis

Sole ulcer

SUMMARY

- Claw health index implemented in the total merit index for Norwegian Red, September 2014

- Use of ssGBLUP to utilize all available information
  - Genotype more cows having claw health records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