



INRAE



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A Single-Step genomic evaluation of claw health traits in French Holstein, Montbéliarde and Normande breeds

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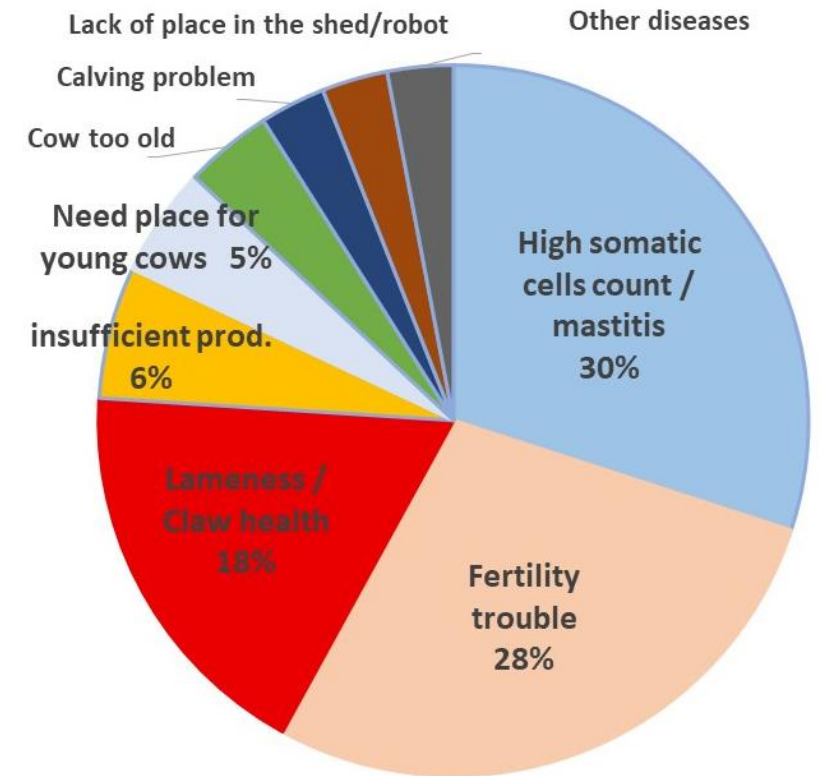
Claw health in dairy cattle

- ✓ A major welfare problem in dairy farming, often causing pain and lameness in cows
- The third most costly disorder & reason for involuntary culling** after mastitis and fertility trouble
- ✓ Multifactorial origin (infectious, traumatic, housing/hygiene, nutritional)
- ✓ 24 claw health traits (described in ICAR Atlas) – **11 mandatory**

French situation & expectations:

- ✓ 5 breeding companies' initiatives in 3 breeds → need for **harmonisation within Holstein & Normande breeds** and to move towards **EuroGenomics Golden standard** in Holstein
- ✓ Model update allowed with the volume of data: Multiple trait – **repeatability** – **Single Step**
- ✓ Include new traits

Survey of reasons for culling on 563 dairy farms



Source : CNIEL/Idele 2022

Population evaluated

Data collection

- 😊 Based on previous regional initiatives, **220 trimmers** collecting data on **Touch Tab**, starting in 2012
- 😞 **Limited** % farm using trimming service
- 😞 **Non-exhaustive data within herd** - Breeders choose cows to be trimmed

Data edits

- Herds enrolled in **official milk recording**, **Purebred** animals
- **Lactations 1 to 5**, **Days In Milk 1 to 550**
- Cows with **at least the 2 rear claw** trimmed
- **Recovery period** after the previous lesion of **4 months**

Phenotyped cows	Holstein	Normande	Montbéliarde
#cows x visit	532 321	83 317	90 519
#cows	299 664	44 825	51 166

Claw health traits

Healthy cow = 12% (Normande) to 21% (Holstein)



1/ Digital & interdigital
Dermatitis (DD)



2/ Interdigital Hyperplasia
(IH)



3/ Heel Horn Erosion
(HHE)



4/ White Line Disease
(WL)



5 & 6 / Sole Hemorrhage
Diffused (SHD)



5 & 6 / Sole Hemorrhage
Circumscribed (SHC)



7/ Sole Ulcer
(SU)



8/ Toe Necrosis/Ulcer
(TN)



9/ Corkscrew Claw
(CSC)



Pictures' source : Atlas ICAR

Genetic Model

➤ Multiple trait, repeatability, animal model

Claw health trait = Fixed effects

severity scores from
0=healthy to
3=severe
Except TN & CSC =
binary traits 0/1

- Herd x trimming date (min 5 cows in Holstein, 4 in Normande & Montbéliarde)
- Trimmer x year
- Calving month x year
- Lactation (1,2,3+) x lactation stage (15 class) x 3 year period
- Calving age (10 class in 1st lact ; 7 class in 2nd ; 1 class per lactation 3 to 5)

+ **Additive genetic effects**

+ **Permanent environment effects**

+ **Residual**

Note1: Due to the infectious status of Dermatitis, only cows recorded as healthy from a herd with affected contemporaries are considered

Note2: Non trimmed cows are excluded – not considered healthy by default

Holstein Genetic parameters Estimation



Heritability, repeatability and genetic correlations estimated with Wombat (K. Meyer)

	Preval. (%)	DD	HHE	IH	SHC	SHD	WL	SU	repeat.
DD	35	0.08	0.68	0.71	-0.08	-0.17	-0.14	0.01	0.18
HHE	39		0.04	0.50	0.22	-0.10	-0.05	0.28	0.09
IH	14			0.10	-0.02	-0.09	-0.06	0.06	0.41
SHC	16				0.04	0.44	0.47	0.89	0.08
SHD	25					0.02	0.43	0.40	0.05
WL	17						0.05	0.63	0.17
SU	13							0.06	0.17
$\sigma_{\text{error } h^2}$		0.005	0.004	0.006	0.003	0.003	0.004	0.004	
$\sigma_{\text{error corrG}}$		0.03-0.06	0.04-0.07	0.03-0.06	0.03-0.06	0.03-0.07	0.04-0.06	0.03-0.06	

Low heritability (2 → 10%), moderate repeatability to fairly high for IH
 2 groups of traits, moderately to highly correlated within groups

Normande & Montbéliarde Genetic parameters Estimation



Normande

	Preval. (%)	DD	HHE	IH	TN	SHC	SHD	WL	SU	repeat.
DD	43	0.08	0.37	0.80	-0.45	-0.25	-0.26	-0.39	-0.27	0.18
HHE	33		0.02	0.18	-0.29	0.11	-0.01	-0.22	0.31	0.04
IH	30			0.22	-0.29	-0.24	-0.23	-0.16	-0.22	0.47
TN	5				0.03	0.23	0.27	0.43	0.22	0.39
SHC	14					0.03	0.50	0.31	0.78	0.06
SHD	29						0.03	0.45	0.30	0.06
WL	28							0.07	0.25	0.23
SU	18								0.07	0.23
$\sigma_{\text{error } h^2}$		0.010	0.004	0.017	0.008	0.005	0.006	0.010	0.009	
$\sigma_{\text{error corrG}}$		0.04-0.12	0.12-0.17	0.04-0.12	0.10-0.17	0.06-0.16	0.03-0.16	0.08-0.14	0.08-0.13	



Montbéliarde

	Preval. (%)	DD	HHE	IH	SHC	SHD	WL	SU	CSC	repeat.
DD	24	0.04	0.58	0.65	0.26	-0.10	-0.02	0.32	-0.20	0.13
HHE	13		0.04	0.34	0.44	-0.03	0.14	0.44	0.11	0.06
IH	13			0.09	-0.01	0.04	-0.02	0.06	-0.08	0.39
SHC	14				0.04	0.26	0.36	0.84	0.36	0.08
SHD	33					0.04	0.17	0.32	0.46	0.06
WL	33						0.08	0.49	-0.02	0.18
SU	10							0.05	0.21	0.19
CSC	15								0.07	0.17
$\sigma_{\text{error } h^2}$		0.006	0.005	0.009	0.005	0.005	0.008	0.006	0.008	
$\sigma_{\text{error corrG}}$		0.07-0.10	0.08-0.10	0.07-0.08	0.05-0.10	0.08-0.10	0.07-0.09	0.07-0.10	0.08-0.09	

A pilot Single Step genetic evaluation

➤ Using HSS-GBLUP (Tribout et al.) – in Winter and Spring 2023

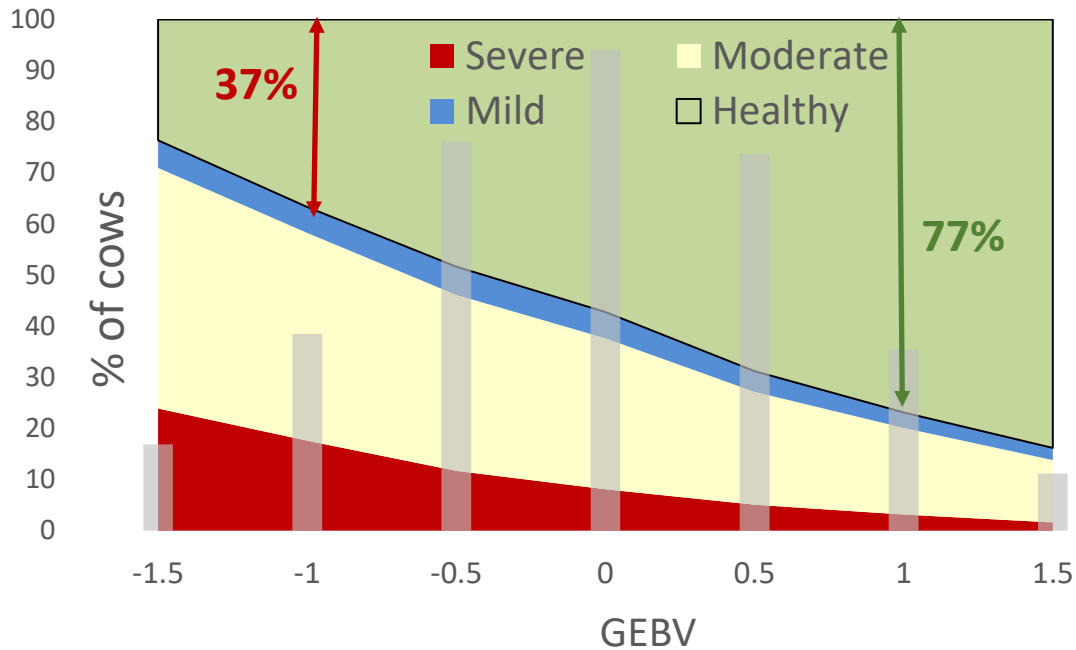
Split the Multitrait in a **3 traits** (DD, IH & HHE) + **6 traits** (TN, SHC, SHD, WL, SU & SCS)

Reduce computation time by 2 to 3

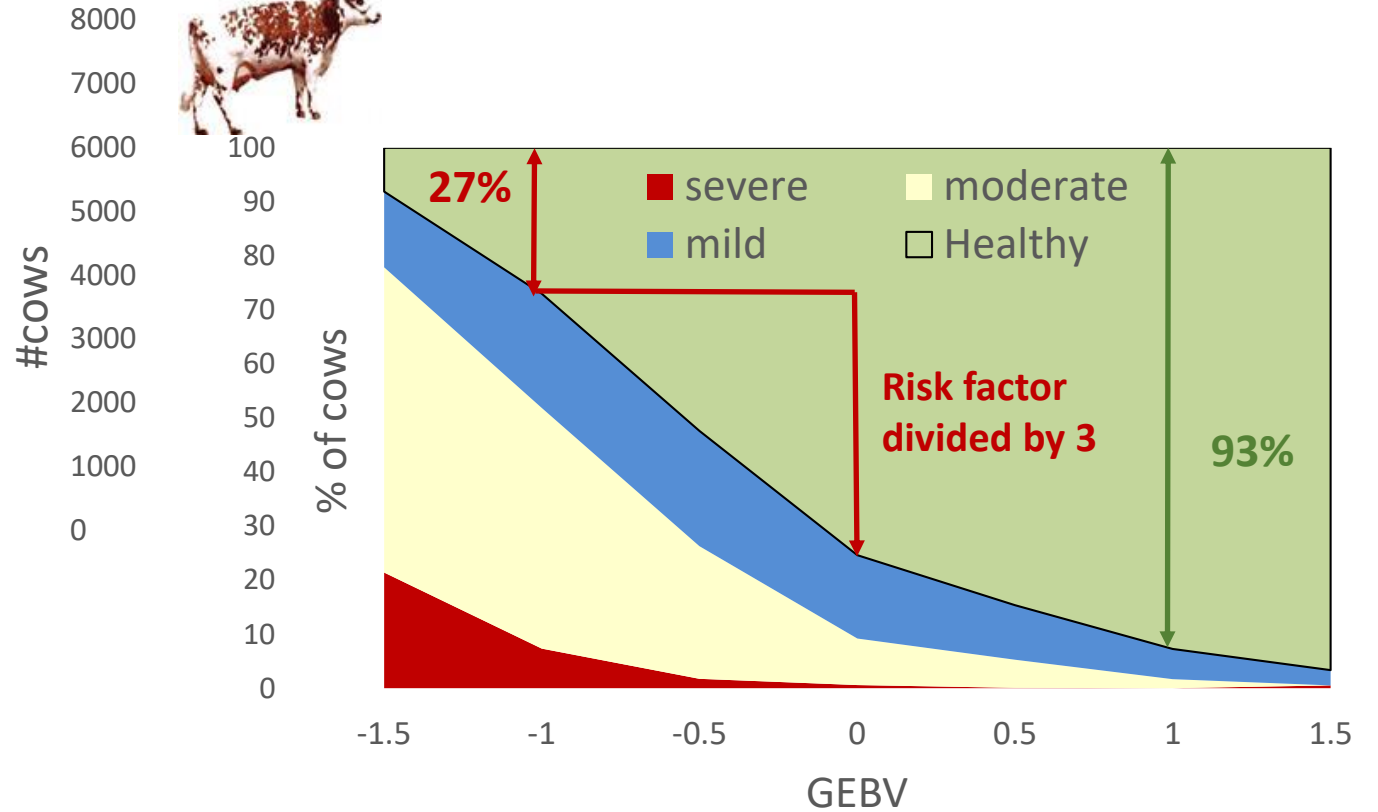
	Holstein		Normande		Montbéliarde	
	Female	Male	Female	Male	Female	Male
#animal with own perf	251 602	0	35 546	0	39 338	0
#animal with daughter perf	205 654	8320	31 792	1 276	30 944	1 753
#genotyped	1 111 448	133 645	162 327	19 912	555 159	45 525
#animals in reference pop	40 670	5 402	12 156	1 135	11 565	1 252

Risk factor according to GEBV

➤ Example with Digital Dermatitis

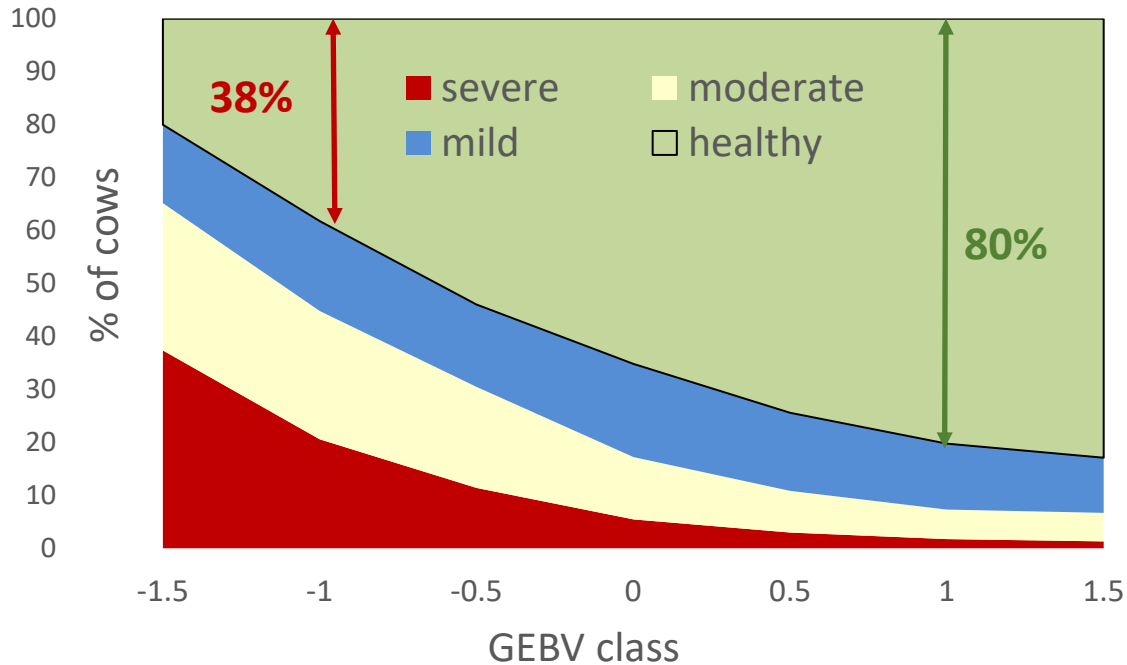


➤ Example with Interdigital Hyperplasia

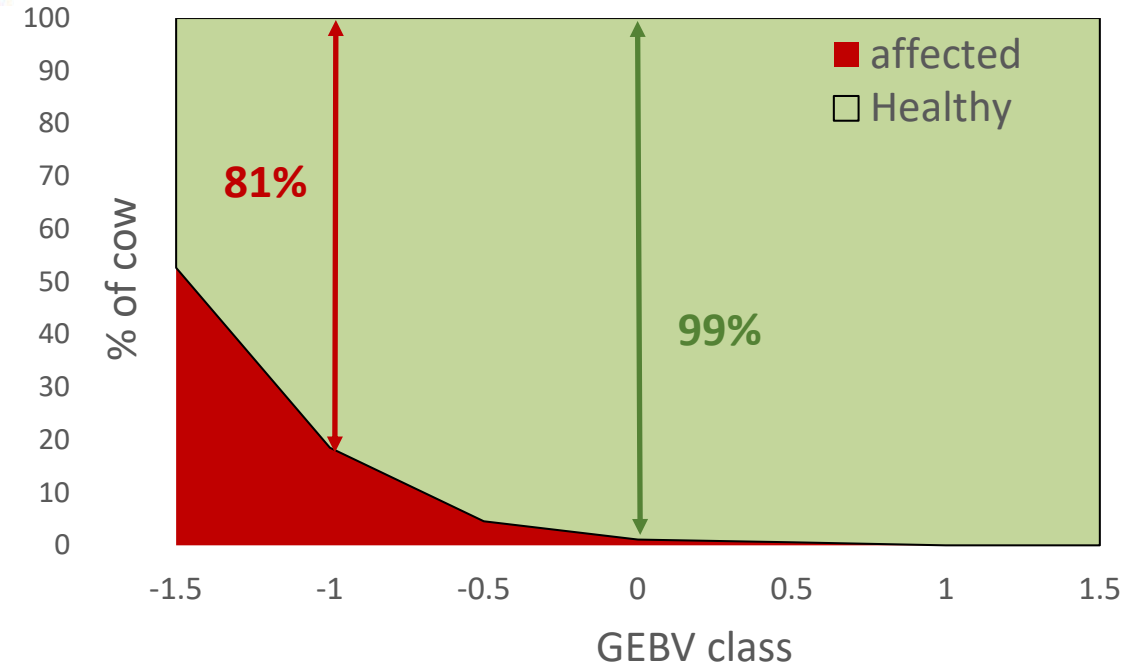


Risk factor according to GEBV

➤ Example with White Line Disease

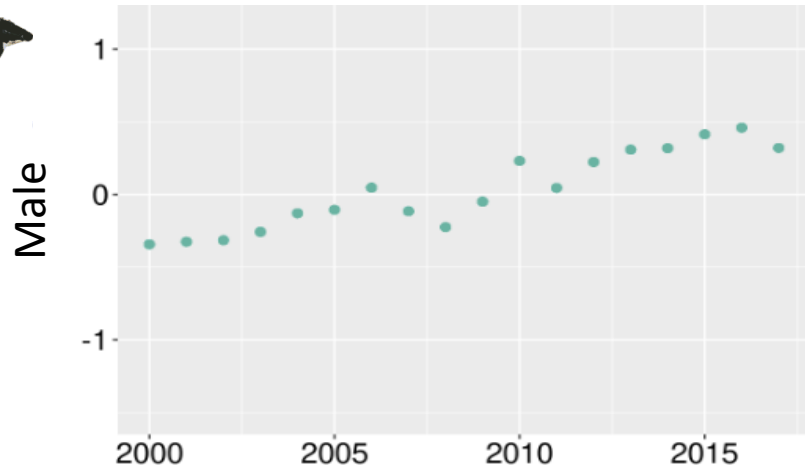


Example with Toe Necrosis

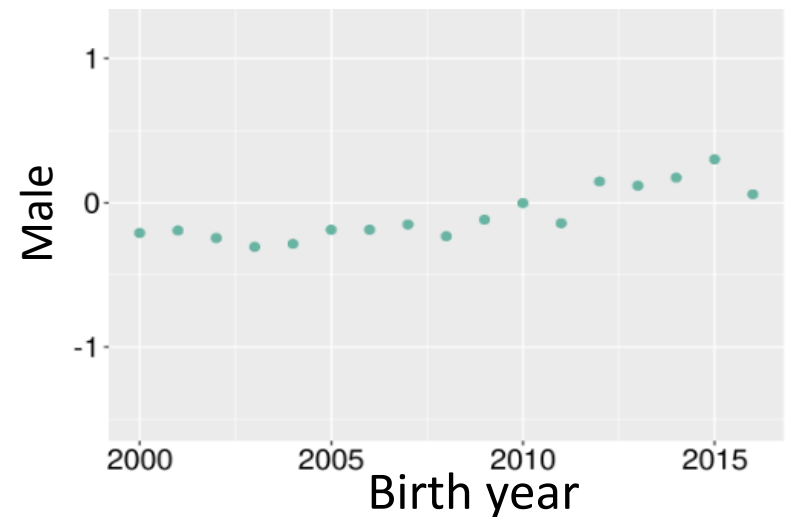
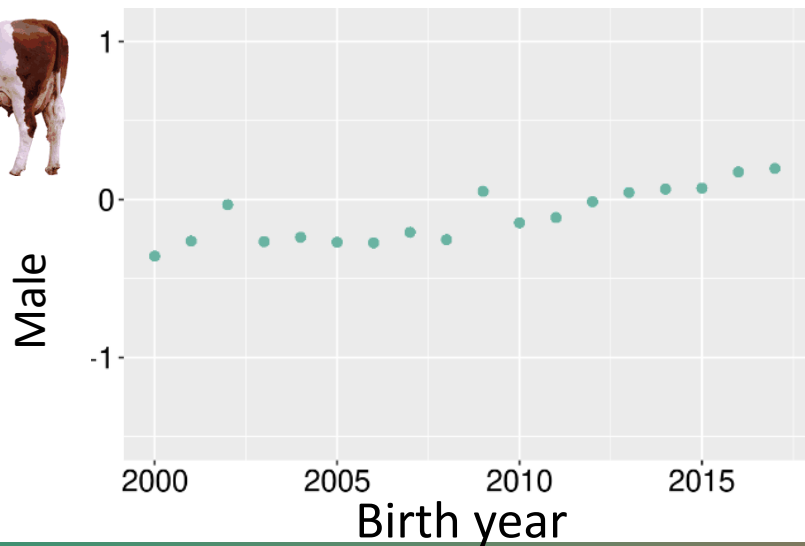
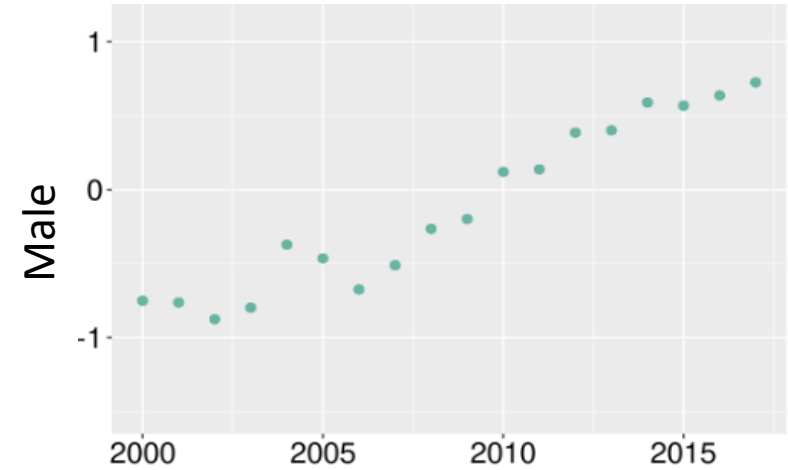


A favourable genetic trend

➤ Digital Dermatitis



➤ Sole Ulcer



Claw health index

➤ Holstein



- Infectious traits index (SLI) = $0.60 \text{ DD} + 0.30 \text{ IH} + 0.10 \text{ HHE}$
- Mechanical traits index (SLM) = $0.40 \text{ SU} + 0.40 \text{ WL} + 0.10 \text{ SHC} + 0.10 \text{ SHD}$
- Claw health index (STPI) = $0.60 \text{ SLI} + 0.40 \text{ SLM}$

➤ Normande



- Infectious traits index (SLI) = $0.60 \text{ DD} + 0.30 \text{ IH} + 0.10 \text{ HHE}$
- Mechanical traits index (SLM) = $0.40 \text{ SU} + 0.25 \text{ WL} + 0.25 \text{ TN} + 0.05 \text{ SHC} + 0.05 \text{ SHD}$
- Claw health index (STPI) = $0.60 \text{ SLI} + 0.40 \text{ SLM}$

➤ Montbéliarde (Umotest Breeding company)



- Infectious traits index (SLI) = $0.60 \text{ DD} + 0.30 \text{ IH} + 0.10 \text{ HHE}$
- Mechanical traits index (SLM) = $0.30 \text{ SU} + 0.45 \text{ WL} + 0.10 \text{ CSC} + 0.10 \text{ SHC} + 0.05 \text{ SHD}$
- Claw health index (STPI) = $0.50 \text{ SLI} + 0.50 \text{ SLM}$

Take Home Message

- **9 traits studied** → 2 groups of traits almost genetically independent of each other
⇒ Split in 3 + 6 traits to limit computational requirements in Single Step.

- **Favourable genetic trend** due to indirect selection on health traits, longevity, feet and legs conformation traits and current total merit index

- Claw health index adapted to  **specificities**

- Claw Health index will be included in future revision of **total merit index**

- First routine evaluation with official release is scheduled in



A collective achievement !





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