Improved genetic evaluation of health traits using metabolic biomarkers in Nordic dairy cattle

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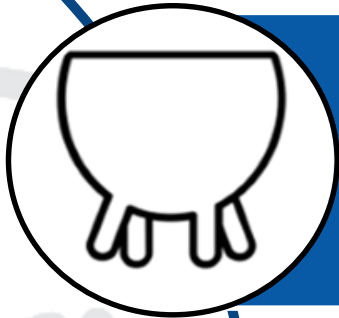[4] **Nordic Cattle Genetic Evaluation**, Aarhus N, Denmark

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Interbull meeting 2018, New Zealand

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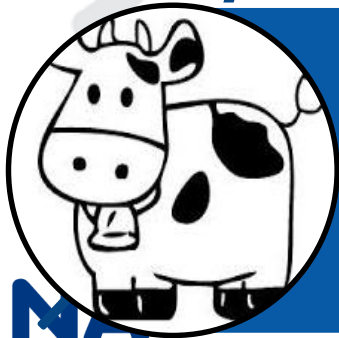
Health traits evaluations

UDDER HEALTH

Clinical mastitis , Cell count (indicator trait)

Udder conformation (indicator traits)

CLAW HEALTH

Claw diseases (trimmers)

GENERAL HEALTH

Reproductive-, Metabolic disorders,
Feet and Leg problems -- Clinical mastitis,
metabolic biomarkers (BHB & Acetone indicator traits)

Health traits evaluations

UDDER HEALTH

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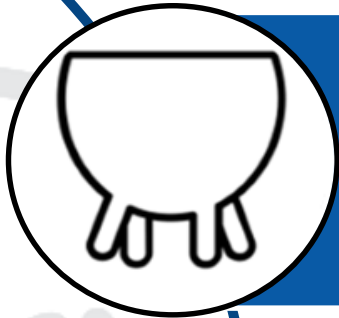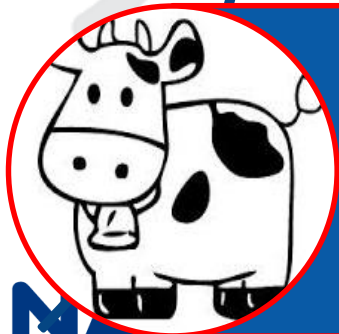**CLAW HEALTH**

Claw diseases (trimmers)

GENERAL HEALTH

Reproductive-, Metabolic disorders,
Feet and Leg problems -- Clinical mastitis,
metabolic biomarkers (BHB & Acetone indicator traits)

General Health index

<u>GH index</u> =   Early Reproductive Disorders (**ERP**)

+ Late Reproductive Disorders (**LRP**)

+ Feet & Leg Problems (**FLP**)

+ *Ketosis (**KET**)*

+ *Other Metabolic Disorders (**OMB**)*

General Health index

GH index = Early Reproductive Disorders (**ERP**)

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Metabolic Disorders	+ *Ketosis (**KET**)*
	+ *Other Metabolic Disorders (**OMB**)*

General Health index

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+ *Ketosis (KET)*

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Metabolic Biomarkers - **New indicator traits**

Metabolic Biomarkers

Ketone bodies detectable in milk samples:

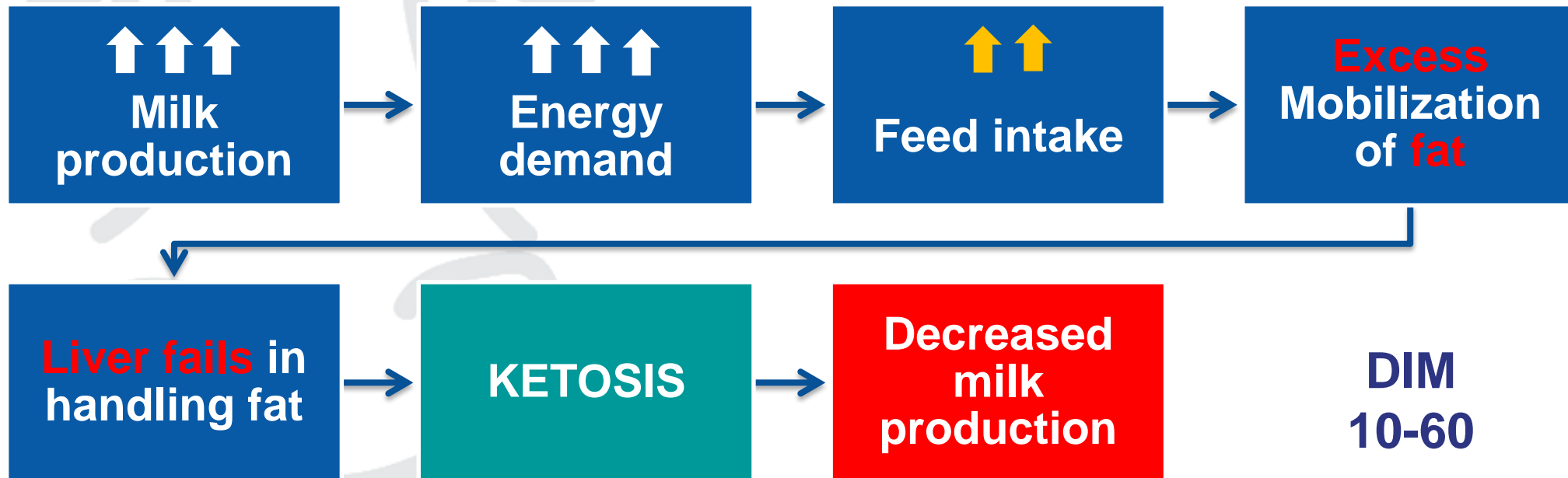## *β-hydroxybutyrate (BHB) & Acetone*

Metabolic Biomarkers

Ketone bodies detectable in milk samples:

β-hydroxybutyrate (BHB) & Acetone

Leading to ketosis:

```
⬆⬆⬆              ⬆⬆⬆              ⬆⬆
Milk             Energy           Feed intake      Excess
production       demand                            Mobilization
                                                   of fat
```

```
Liver fails in    KETOSIS          Decreased        DIM
handling fat                       milk             10-60
                                   production
```
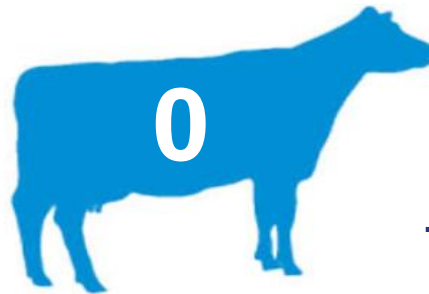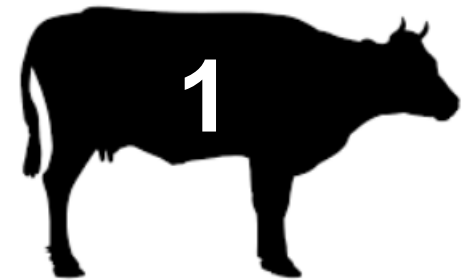
Data – Disease traits

- **Treatment records since the 80's**

- **Veterinarians, AI technicians and Farmers**

- **Breeds:** Holstein, Jersey and Red Dairy Cattle (RDC)

- **Lactations 1-3**

- **Defined as binary 0/1 trait**

Healthy
non-treated

0

Sick
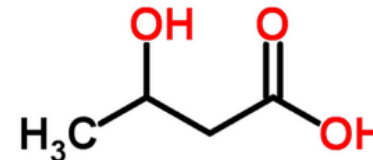treated

1

Data - BHB and Acetone

- **Since 2013 –** Denmark

- **From 2018 –** Finland and Sweden

- **Routine predictions from milk samples collected within the milk recording scheme –** mmol/L

- **Lactations** 1-3

Acetone

BhB
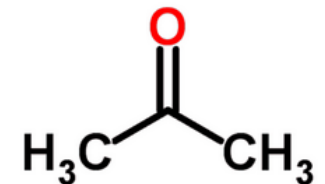
Trait definitions

Ketosis
Other metabolic disorders
Feet and leg problems (+ clinical mastitis)
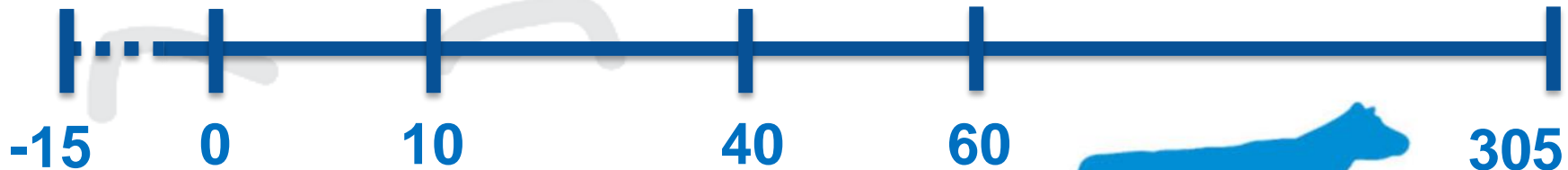
-15   0   10   40   60   305

DIM

Trait definitions

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BHB
Acetone

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Late Reproductive disorders

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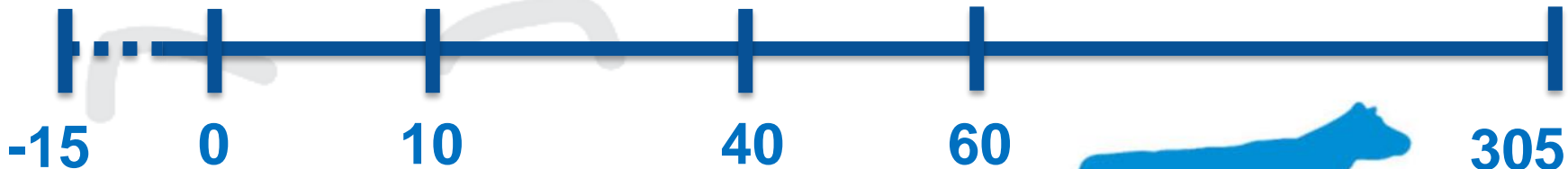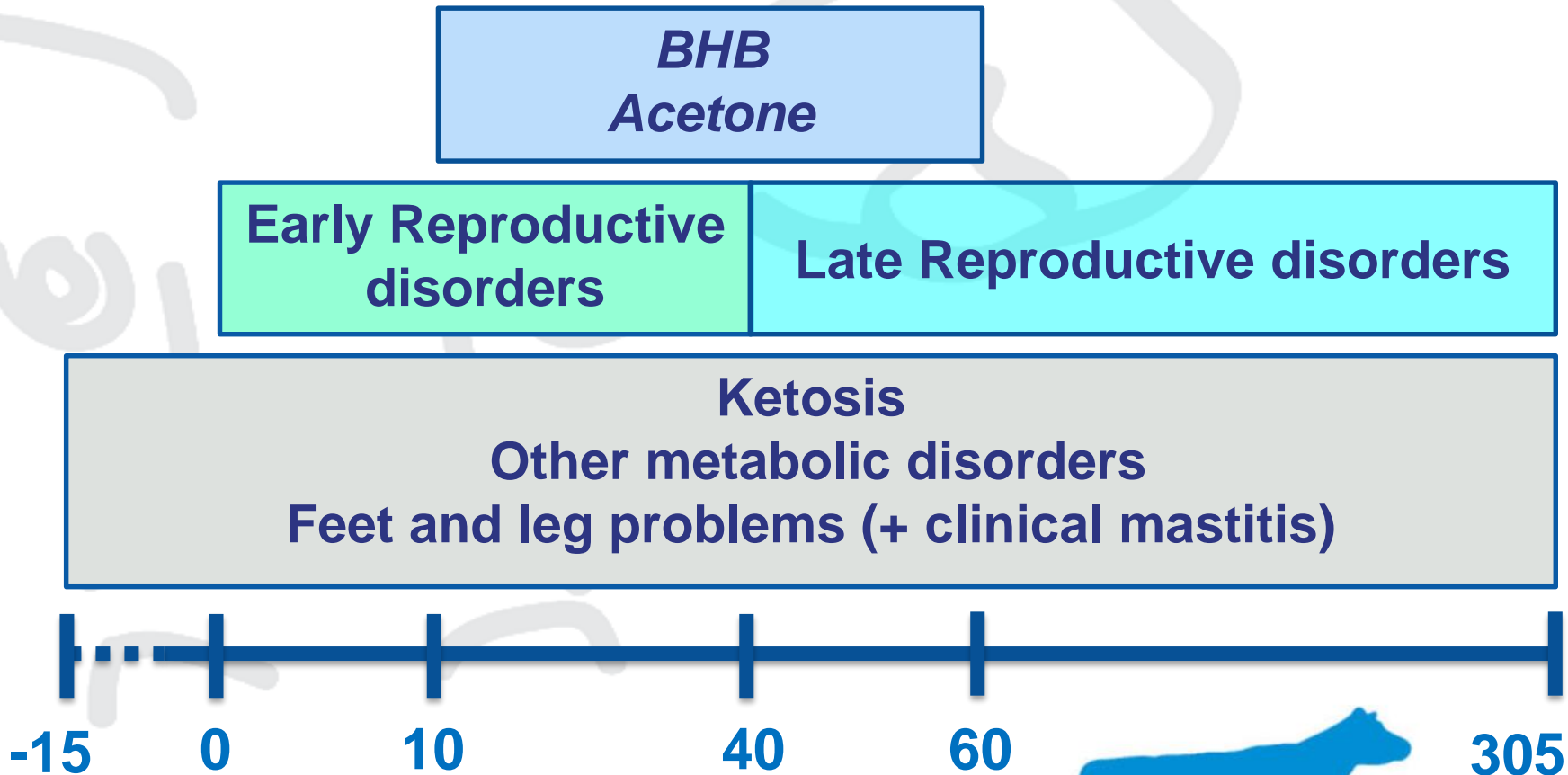
Model - Multi-trait multi-lactation animal model

Fixed effects

Herd-year * country

Calving age * country

Year-month calving * country

Random effects

Animal

Cow Permanent environmental effect *(only BHB/Acetone)*

(fixed) Regression

Lactation stage *(only BHB/Acetone)*

Breeds and heterosis *(only HOL)*

**Pre-adjustment for heterogeneous variance

Heritabilities and genetic correlations
Holstein, lactation 1

	Early reproductive disorders	Late reproductive disorders	Other metabolic disorders	Ketosis	Feet and leg problems
Early reproductive disorders	**0.020**	0.40	0.40	0.29	0.35
Late reproductive disorders		**0.010**	0.29	0.21	0.36
Other metabolic disorders			**0.006**	0.74	0.38
Ketosis				**0.012**	0.19
Feet and leg problems					**0.010**

Low heritabilities & low, moderate to high genetic correlations

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Holstein, lactation 1

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Low heritabilities & low, moderate to high genetic correlations

Heritabilities and genetic correlations
Holstein, lactation 1

	Other metabolic disorders	Ketosis	BHB	Acetone
Other metabolic disorders	**0.006**	0.74	0.48	0.65
Ketosis		**0.012**	0.65	0.76
BHB			**0.15**	0.88
Acetone				**0.06**

Low to moderate heritabilities & high genetic correlations

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Low to moderate heritabilities & high genetic correlations

Value of including BHB & acetone

Reliabilities for cows with or without BHB and Acetone observations, that have veterinary treatment observations but not own progeny

Breed	BHB & Acetone obs	Other Metabolic disorders	Ketosis	GH index
HOL	Yes	0.34	0.36	0.32
	No	0.29 **15%**	0.29 **19%**	0.30 **6%**

Summary

- New objective indicator traits for Ketosis in the General Health evaluation
  - Diagnosis for subclinical and clinical ketosis

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- New objective indicator traits for Ketosis in the General Health evaluation

    - Diagnosis for subclinical and clinical ketosis

- Metabolic biomarkers showed favorable and high genetic correlations with Ketosis

- Higher heritability of BHB and acetone than for Ketosis

- The inclusion of the metabolic biomarkers increases cow EBV reliability, especially for ketosis and metabolic disorders

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Summary

- The new General Health evaluation was introduced November 2017 for all breeds (Holstein, RDC and Jersey)

November 2017

Disease traits and sub-traits used in the GH evaluation

Early reproductive disorders	Late reproductive disorders	Ketosis	Other metabolic diseases	Feet and leg problems
• Retained placenta • Hormonal reproductive disorders • Infective reproductive disorders • Other reproductive disorders	• Hormonal reproductive disorders • Infective reproductive disorders • Other reproductive disorders	• Ketosis • *BHB* *(β-hydroxybutyrate)* • *Acetone*	• Milk fever • Other metabolic diseases • Other feed related disorders • Other diseases	• Feet and legs disorders

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Disease frequencies in % - HOLSTEIN

Traits	DNK	SWE	FIN
ERP	12	2	3
LRP	4	8	13
KET	5	<1	2
OMB	2-9*	1-7	2-8
F&L	8	3	2

*Lactation 1 to lactation 3

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Disease frequencies in % - RDC

Traits	DNK	SWE	FIN
ERP	8	2	3
LRP	2	6	12
KET	1-4*	<1	1
OMB	1-7	1-5	1-6
F&L	7	2	2

*Lactation 1 to lactation 3

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Disease frequencies in % - Jersey

Traits	DNK
ERP	3
LRP	2-3*
KET	2-3
OMB	2-15
F&L	5-7

*Lactation 1 to lactation 3