Genetic parameters for longitudinal welfare and disease indicator traits generated in automatic milking systems

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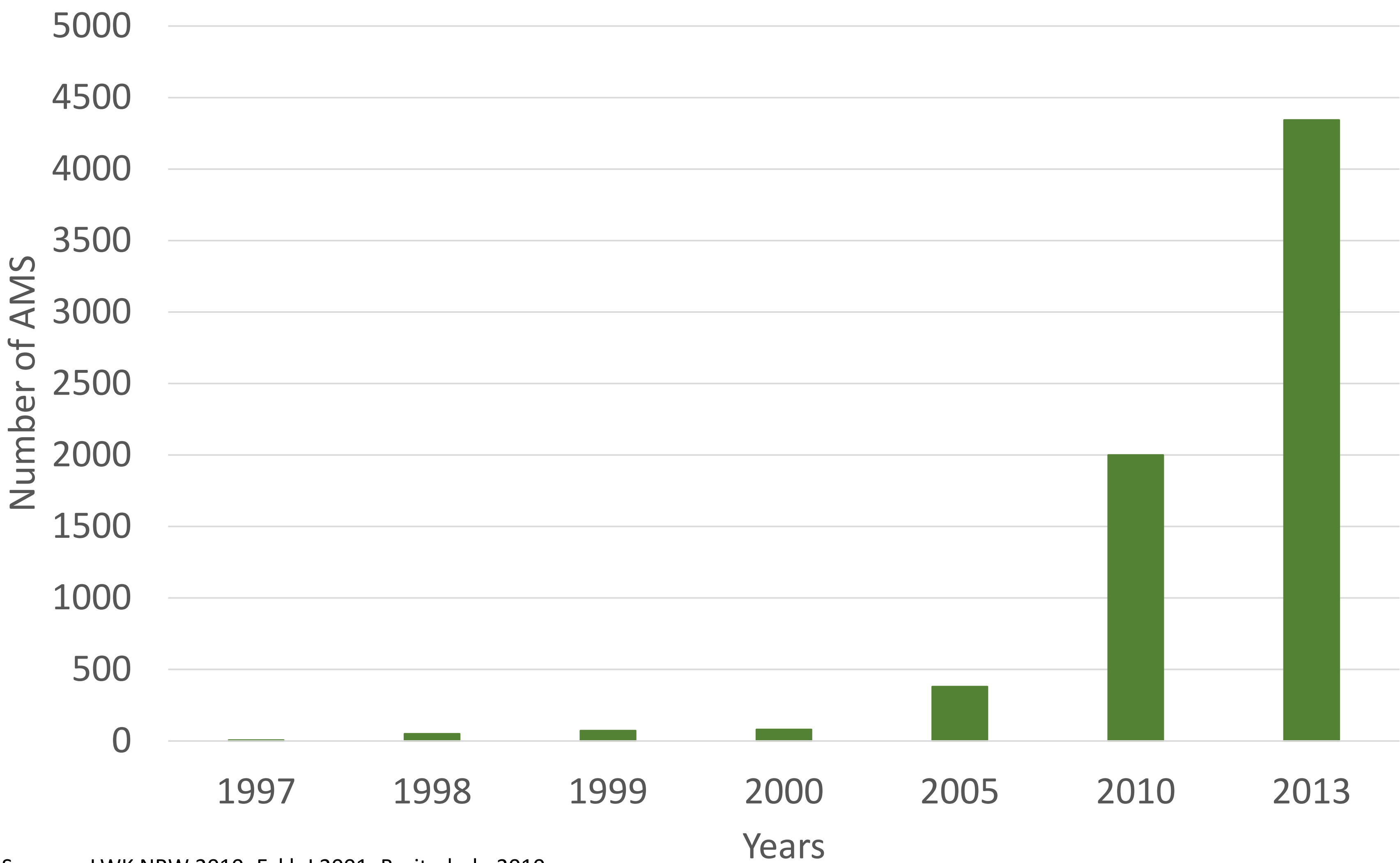
Source: Google Image

Breeding strategies

- Future breeding strategies will focus on novel functional traits:
  - Health traits
  - Behavior traits
  - Welfare traits
- Challenges:
  - Functional traits generally show low heritability and are difficult or expensive to measure
  - Behavior traits are mainly measured subjectively
  - E.g. milking temperament (1:very nervous; 5: very calm)
- Adoption of new technologies is accelerating ’ AMS

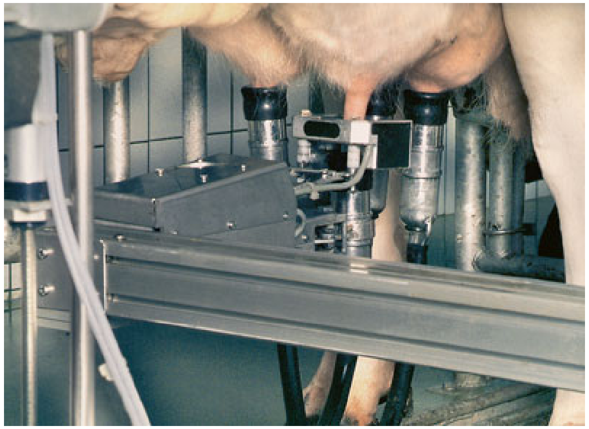
Number of AMS in Germany



Sources: LWK NRW 2010; Eckl, J 2001; Breitschuh, 2010

Potential of AMS for data collection of novel traits

- Automatic repeated measures, longitudinal data and objective data recording
  - Recording and storing of technical parameters for every individual milking visit
  - E.g. milking speed, milking duration, knock-off of the milking device, electrical conductivity
- Technical parameters can be used to define new behavior- and milking efficiency traits, e.g.:
  - Temperament
  - Health



Source: Landwirt.com

Aim of the study

1. To identify and define **novel functional milking traits** reflecting the categories
   – Temperament
   – Health

   based on data collected in automatic milking systems

2. To infer **genetic relationships**
   – Among those novel traits
   – With traits from official milk performance testing

3. In order to develop more balanced breeding strategies with higher emphasis on animal welfare

Material and Methods

- 3 farms with the same AMS producer
  - Each farm had an average of 350 animals
- In total 884 animal records and 58.664 observations in a 30 days period
  - AMS observations
- Official test-day-records
  - Close to the 30 days we extracted from the AMS
- Fertility records for 765 cows
- Pedigree with 20.866 animals

Novel trait definitions

Trait (structure)	Definition	Indicator
AMF (Gauß)	average milk flow	temperament
CON (Gauß)	electrical conductivity	udder health
DUR (Gauß)	time spent during a visit in the milking machine	stress, temperament
INT (Gauß)	interval between two consecutive milkings	social dominance, temperament
VIS3 (binary)	more than 3 visits a day	social dominance, curiosity, temperament
VIS2 (binary)	more than 2 visits a day	
KO (binary)	at least one of the milking devices is knocked off	general discomfort, temperament
NRR90 (binary)	non return rate 90	fertility

Descriptive statistics

	Statistical parameters			
Traits/Effects	Mean	SD	Minimum	Maximum
MY (kg)	12.85	4.41	1.53	30.29
AMF (kg/min)	1.12	0.30	0.30	2.07
CON (mS/cm)	4.95	0.41	3.91	6.30
SCS	2.72	1.64	0.16	8.68
DUR (min)	6.43	2.00	1.02	31.68
INT (h)	9.22	3.00	0.00	24.00
VIS3	0.23	0.42	0	1
VIS2	0.60	0.49	0	1
KO	0.08	0.28	0	1
NRR90	0.25	0.43	0	1

Model I - Linear Model -

- For traits **AMF**, **INT**, **CON** and **DUR**

$$\mathbf{y_{ijklmnopq} = \mu + Robot_i + LN_j + Date_k + Intcl_l + DIM_m + ToD_n + CA_o + pe_p + a_q + e_{ijklmnopq}\ (I)}$$

- µ = Population mean
- Robot = AMS consecutively numbered across herds
- LN = Lactation number 1 - 5
- Date = Day the cow entries the AMS
- Intcl = Interval in classes < 8 h = 1; 8 h – 10 h = 2; > 10 h = 3 **not for INT**
- DIM = According to Huth 1995
- ToD = Time of day in classes 10 p.m. – 4 a.m. = 1; 4 a.m. – 10 a.m. = 2; 10 a.m. – 4 p.m. = 3; 4 p.m. – 10 p.m. = 4
- CA = Calving age (linear regression)
- pe = Permanent environmental effect
- a = Additive genetic effect; e = Residual effect

Model II and III - Threshold Models -

- For **VIS3**, **VIS2** and **KO**

$$\mathbf{u_{ijklmnopq} = \varphi + Robot_i + LN_j + Date_k + Intcl_l + DIM_m + ToD_n + CA_o + pe_p + a_q \ (II)}$$

- For **VIS3** and **VIS2** the effects Intcl and ToD were not significant and excluded from the model

- For **NRR90**

$$\mathbf{u_{ijklmnopq} = \varphi + Herd_i + Season_j + LN_k + DIM_l + C\text{-}S_m + a_n \ (III)}$$

- Herd = The three herds
- Season = Conception season in classes; March – May = 1; June – August = 2; September – November = 3; December – February = 4
- C-S = Interval from calving to first service

Variance components and heritabilities for traits of interest

Traits	σ_a^2	σ_{pe}^2	σ_e^2	$h^2 \pm SE$	w^2
AMF (kg/min)	0.09	0.13	0.13	0.25 ± 0.07	0.63
DUR (min)	0.57	1.28	1.23	0.19 ± 0.07	0.60
INT (hour)	0.42	1.44	4.15	0.07 ± 0.03	0.31
KO	0.17	1.44	3.29	0.03 ± 0.03	0.33
VIS3	0.38	1.11	3.29	0.08 ± 0.03	0.31
VIS2	0.30	2.01	3.29	0.05 ± 0.05	0.41
MY (kg)	1.62	3.49	4.13	0.18 ± 0.06	0.55
CON (mS/cm)	0.07	0.03	0.03	0.53 ± 0.09	0.77

Correlations

Trait	AMF	DUR	INT	KO	VIS3	VIS2	MY
AMF		-0.88 (0.08)	0.14 (0.23)	0.17 (0.40)	-0.24 (0.23)	-0.20 (0.34)	0.40 (0.19)
DUR	-0.631		-0.15 (0.28)	-0.25 (0.47)	0.28 (0.27)	0.37 (0.38)	0.87 (0.35)
INT	0.017	-0.088		-0.19 (0.47)	-0.62 (0.19)	-0.88 (0.22)	-0.51 (0.23)
KO	-0.018	0.057	-0.129		0.24 (0.47)	0.55 (0.79)	0.21 (0.42)
VIS3	-0.001	0.107	-0.963	0.127		n.c.	0.49 (0.23)
VIS2	-0.003	0.124	-0.855	0.209	0.842		0.81 (0.30)
MY	0.473	0.251	-0.524	0.053	0.522	0.471	

n.c. = not converged

Conclusions

- AMS provides a large amount of objectively measured data
- Utilization of this data as health and behavior indicators for livestock is still largely unrealized
- CON as a new indicator for udder health; higher heritability as SCS (heritability between CON and SCS = 0.21 œ0.10)
- Moderate heritabilities for AMF (0.25 ± 0.07) and DUR (0.19 ± 0.07)
- Breeding value for AMS already exists (RZRobot)
- Consideration to add some of these behavior traits to RZRobot in order to breed for a favorable temperament and for cows more suitable to AMS

Thank you very much for your attention!

Source: Google Image

Acknowledgment: Project funding is made within the LOEWE focus of the Hessian Ministry for Science and Art