Christian-Albrechts-Universität
zu Kiel
Institut für Tierzucht und Tierhaltung

Genetic Analysis of Several Economic Important Disease Traits in German Holsteins Cows

G. Thaller, D. Hinrichs, E. Stamer and W. Junge

**Institut für Tierzucht und Tierhaltung
der Christian-Albrechts-Universität zu Kiel**

Introduction

Dairy production today

- very high level of performance traits
- increasing herd sizes
- increasing occurrence of diseases
- time for observing cows limited

=> ‚functional and healthy cow‘

Introduction

Genetic improvement requires

- Definition of traits
- Recording schemes
- Knowledge of genetic parameters
- Economic weights
- Inclusion in breeding goal

Introduction

Organized performance testing

- 3 farms – 3200 cows
- Recording period 2/1998 – 12/2008
- Data from 10.000 cows in total
- 800 bulls ~ ‚HF world‘
- 4 mio. lactation days
- 75.600 registered treatments

Data Recording

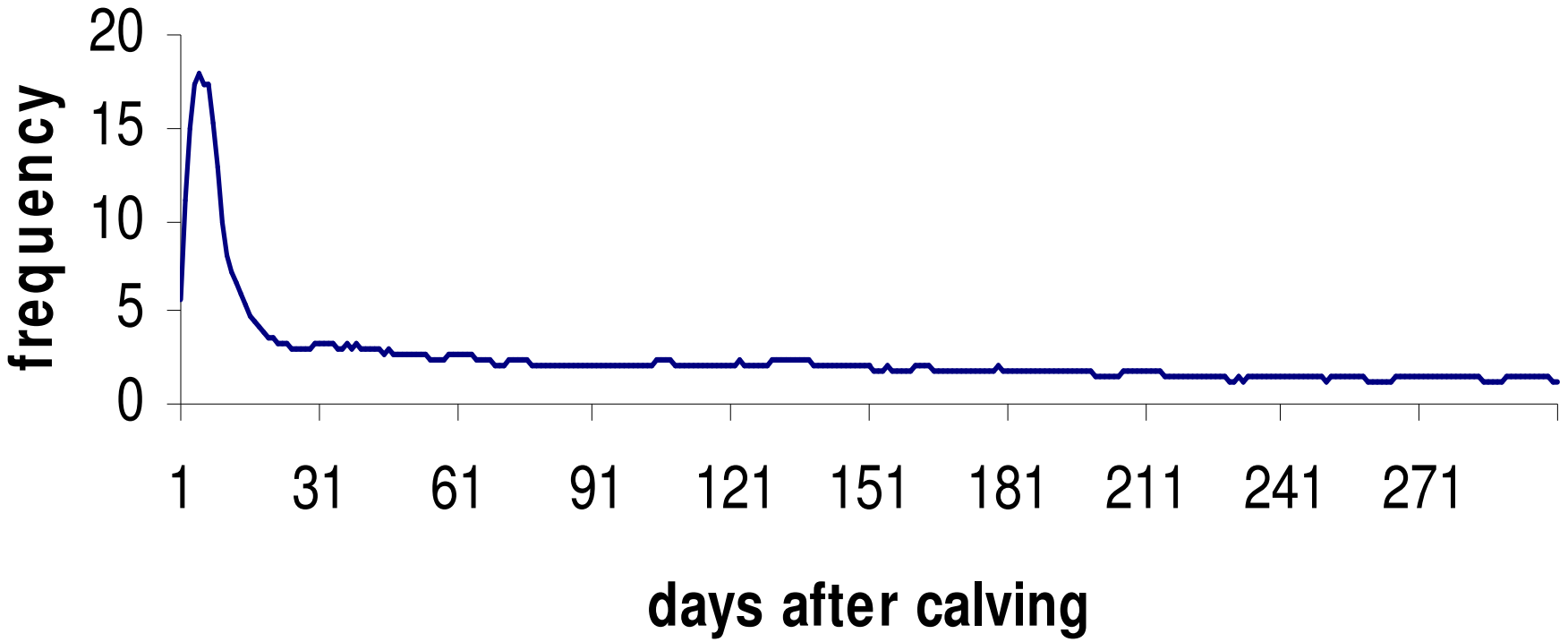
Recording diseases / treatments

- Herd management program
- Protocol of diseases
- Bills of veterinarians
- Notes of veterinarians
- Notes of farm workers
- 222 different ‚diagnoses‘
- Combined into groups

Traits and Treatments

Disease Category	Cases
Udder diseases	39943
Masitis	38225
Non mastitis	1709
Fertility diseases	24563
Distortion of cylcus activity	11833
Other (endo-metritis)	12730
Metabolic diseases	4131
Claw and leg diseases	5085
Other	1881

Distribution of mastitis cases accross lactation

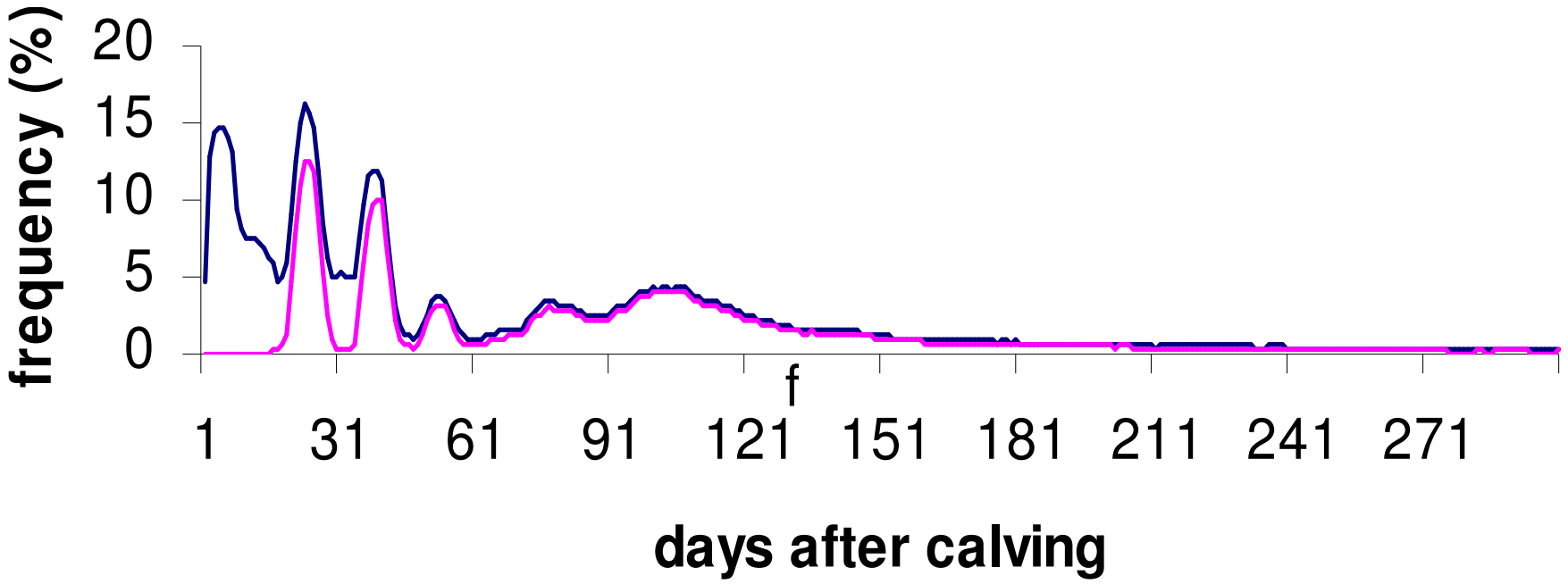


Maximum: 18 % at day 5

Disease frequencies – periods
- mastitis -

Recording period: 50 days	
Cows affected:	30,3 %
per day:	5,9 %
Recording period: 100 days	
Cows affected:	35,6 %
per day:	4,2 %
Recording period: 300 days	
Cows affected:	46,0 %
per day:	2,7 %

Distribution of fertility disorders accross lactation

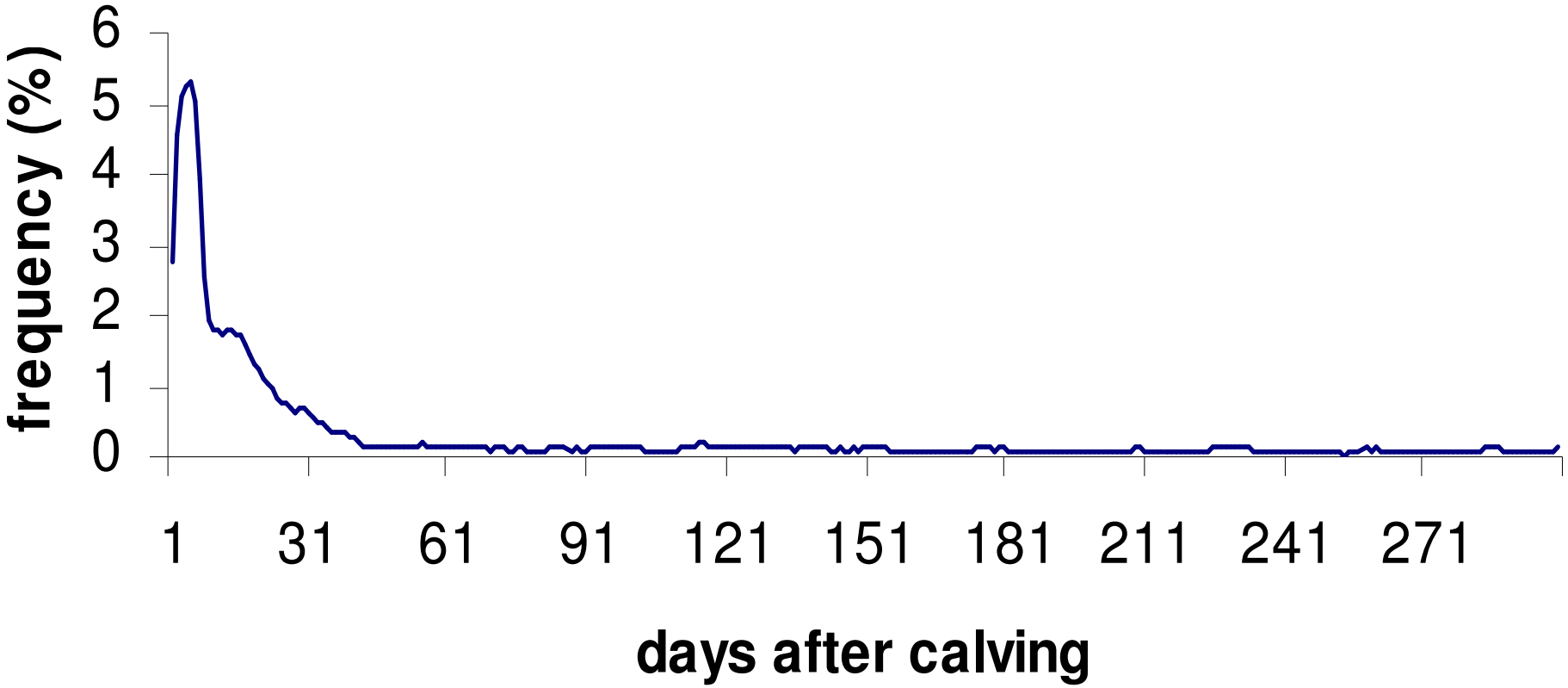


Several pronounced peaks – distortion in cyclicity

Disease frequencies – periods
- fertility traits -

Recording period: 50 days	
Cows affected:	**37,9 %**
per day:	**8,1 %**
Recording period: 100 days	
Cows affected:	**44,3 %**
per day:	**5,5 %**
Recording period: 300 days	
Cows affected:	**50,4 %**
per day:	**2,7 %**

Distribution of metabolic diseases accross lactation

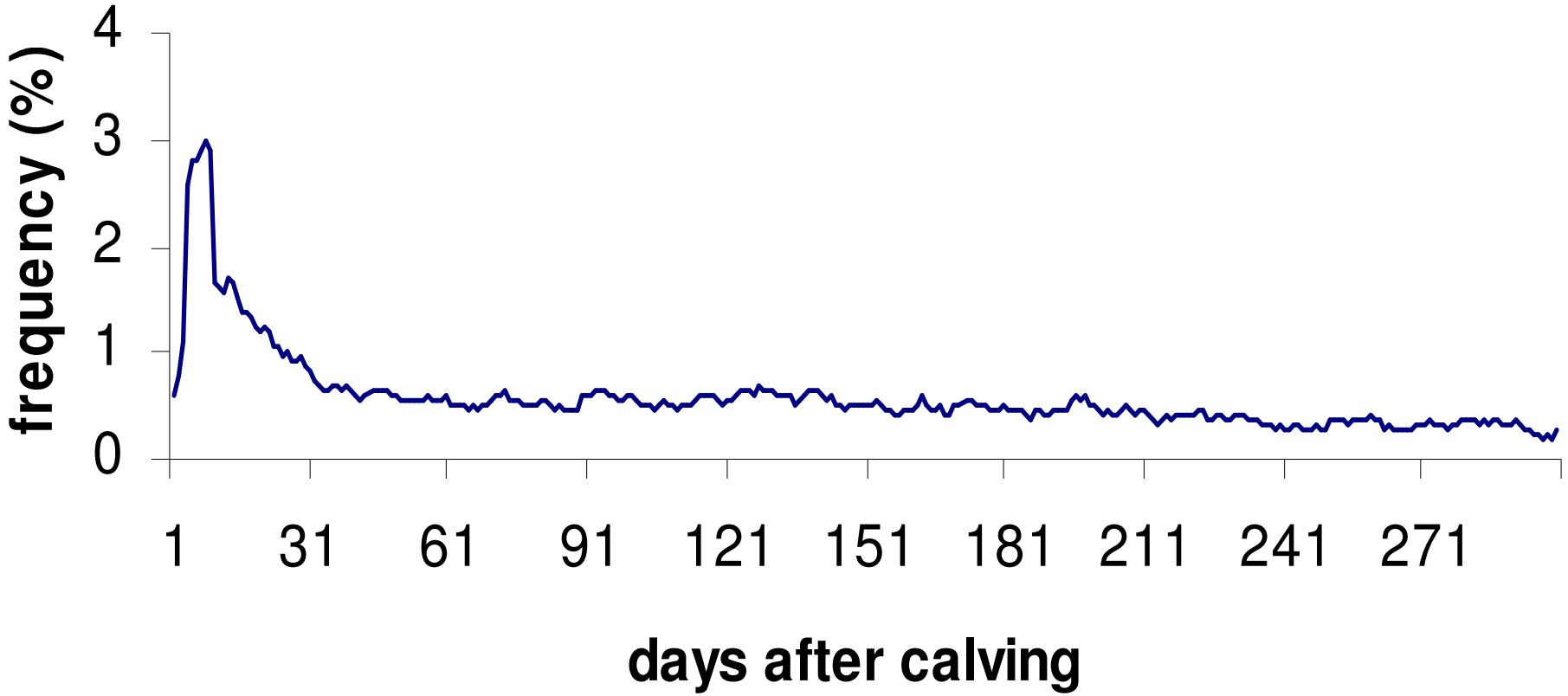


Maximum: 5 % at day 5

Disease frequencies – periods
- metabolic diseases -

Recording period: 50 days	
Cows affected:	**10,4 %**
per day:	**1,6 %**
Recording period: 100 days	
Cows affected:	**11,1 %**
per day:	**0,9 %**
Recording period: 300 days	
Cows affected:	**12,6 %**
per day:	**0,4 %**

Distribution of claw and leg diseases accross lactation



Maximum: 3 % at day 8

Disease frequencies – periods
- claw and leg diseases -

Recording period: 50 days	
Cows affected:	**8,1 %**
per day:	**1,2 %**
Recording period: 100 days	
Cows affected:	**10,0 %**
per day:	**0,9 %**
Recording period: 300 days	
Cows affected:	**14,3 %**
per day:	**0,6 %**

Model for Analysis

Linear or threshold models ?

Testday or (part)- lactation model ?

Linear vs Threshold Model

Advantage of Threshold models

→ Normal distribution is not necessary

→ Use more information of binary traits

Disadvantage of Threshold models

→ computational intensive

→ only few programs available (LMMG_TH, DMU)

Lactation vs Test-day Model

Advantage of lactation threshold models

→ smaller data sets

→ reduced computation time

Disadvantage of lactation threshold models

→ Repeated diseases can not taken into account

→ only one observation per lactation

→ modelling of fixed effects

Lactation threshold model

$$E[\pi_{ijkl}] = \Phi (HCS_i + CA_j + c_1 x + c_2 x^2 + m_k + t_l)$$

$E[\pi_{ijkl}]$ = expected proportion of diseases
Φ = cumulative normal distribution function
HCS_i = effect of the i-th herd*calving-season- class
CA_j = effect of j-th calving-age class
$c_1 x$ = linear regression on lactation length x
$c_2 x^2$ = quadratic regression on lactation length x
m_k = permanent effect of the k-th cow
t_l = random effects of the l-th animal

Test-day threshold model

$$E[\pi_{ijklmn}] = \Phi(HW_i + HCS_j + CA_k + f_{k(lactationday)} + m_l + t_m)$$

$E[\pi_{ijkl}]$ = expected percentage of disease

Φ = cumulative probability function of the standard normal distribution

HW_i = effect of i-th herd week

HCS_j = effect of j-th herd*calving-season

CA_k = effect of k-th calving age class

$f_{k(lactationday)}$ = lactation curve within calving age class k

m_l = permanent environment of l-th animal

t_m = effect of m-th animal

$f_{k(lactationday)}$ = (lactationday/380) + $(lactationday/380)^2$ + log (380/lactationday) + $[\log (380/lactationday)]^2$

Results Lactation Threshold Models

Udder diseases

Model	δ^2_a	δ^2_{pe}	h^2	w
LATM50	0,10	0,11	0,08	0,17
LATM100	0,10	0,09	0,08	0,15
LATM300	0,08	0,12	0,07	0,17

Standard errors of estimates 0,02

Results Lactation Threshold Models

Fertility disorders

Model	δ^2_a	δ^2_{pe}	h^2	w
LATM50	0,06	0,05	0,05	0,10
LATM100	0,04	0,06	0,03	0,09
LATM300	0,06	0,08	0,05	0,12

Standard errors of estimates 0,015

Results Lactation Threshold Models

Metabolic diseases

Model	δ^2_a	δ^2_{pe}	h^2	w
LATM50	0,15	0,20	0,11	0,26
LATM100	0,13	0,20	0,10	0,25
LATM300	0,10	0,19	0,08	0,22

Standard errors of estimates 0,02 – 0.03

Results Test-day Threshold Models

Udder diseases

Model	δ^2_a	δ^2_{pe}	h^2	w
TDTM50	0,58	1,80	0,17	0,70
TDTM100	0,44	1,30	0,16	0,64
TDTM300	0,24	0,83	0,12	0,52

Standard errors of estimates 0,02 – 0.03

Results Test-day Threshold Models

Fertility disorders

Model	δ^2_a	δ^2_{pe}	h^2	w
TDTM50	0,39	1,16	0,06	0,25
TDTM100	0,23	0,97	0,05	0,22
TDTM300	0,17	0,63	0,04	0,21

Standard errors of estimates 0.03 – 0.04, Convergence problems

Results Test-day Threshold Models

Metabolic diseases

Model	δ^2_a	δ^2_{pe}	h^2	w
TDTM50	0,91	3,16	0,18	0,80
TDTM100	0,78	2,84	0,17	0,78
TDTM300	0,43	2,12	0,12	0,72

Standard errors of estimates 0,01 – 0.03

Lactation vs Test-day Model

in favor of test day models

- higher repeatibility
- higher heritability
- advantages especially, if consecutive treatments in cows

but

modelling of disease frequency not uncritical

Comparison of Models
- example udder diseases -

Rank correlation between breeding values

Model	LAS100	LAS300	TSM50	TSM100	TSM300
LAS50	0,93	0,86	0,73	0,79	0,80
LAS100		0,94	0,57	0,72	0,78
LAS300			0,51	0,68	0,79
TSM50				0,86	0,68
TSM100					0,87

LAS = Lactation Threshold Model; TSM = Test Day Threshold Model

Summary

Trait definition and data recording

- High variability in diagnoses

  => keys for disease categories

- Trade-off between precision and frequency for single diseases

- High frequencies when considering cow incidence in (part)-lactations

- Most cases occur in the beginning of lactation

Summary

Modelling disease cases

- Threshold models preferable
- Daily observations describe much better the course of the disease
- Test-day model should be used – functions for disease incidence?
- Incidences (and parameters) suggest to concentrate at the beginning of lactation

  (cost for recording!)

Summary

Practical application

- Healthy cows of increasing interest by farmers and consumers
- Recording in farms possible, has to be properly organized (and paid?)
- Selection of farms

  * often well managed

  * do they represent the average?

Summary

Practical application

- **Heritabilities are sufficient for disease traits being considered for selection purpose**
- **Weight of disease traits in breeding goal**

  - economic weights

  - attitude of consumers and society (?)

Summary

Outlook

- Use of additional information to better estimate breeding values for diseases as ‘direct traits’
- Example mastitis

  - b.v. for SCC available

  - b.v. of correlated type traits (udder cleft and udder depth)

  - combination using index theory


Thank you for attention
WOLFHARD SCHULZE