Selection for Disease Resistance

Gert Pedersen Aamand
Nordic Cattle Genetic Evaluation

Why breeding for resistance?

- Low heritability
- Expensive registration system

However:

- Large genetic variability
- Reasonable reliability (large daughter groups, genomic selection)

Breeding is a strong tool!

Selection for Disease Resistance

1. Introduction
2. Data collection
3. Genetic evaluation
4. Breeding goal
5. Genetic progress
6. Final remarks and conclusion

Disease - health

- Reduce animal welfare
- Economic losses for farmers extra costs:
  - Veterinarian treatments
  - Labour
  - Decreased production
  - Discarded milk
  - Involuntary culling

Disease - health

An improvement of health is desirable:

- From a general ethical point of view
- As it leads to increase consumer acceptance
- It is of economic importance to the farmer

Disease - health

An improvement of health can be reached by:

- Management

and

- Genetic

A good registration system is essential for both management and genetic improvements

Frequencies udder diseases, Denmark

Breed	1st lact Day 0-50	1st lact Day 51-305	3rd lact
RDC	14.3	10.4	22.2
Holstein	12.1	11.9	25.9
Jersey	18.4	9.2	27.3

Frequencies claw diseases, Denmark

Breed	1st lact	3rd lact
RDC	37.2	45.5
Holstein	52.2	56.0
Jersey	25.7	29.7

Holstein has room for genetic improvement

Disease recording

- Registrations
  - User friendly systems important
  - Transfer from invoicing systems or by use of electronic data processing software (disk top, PDA, smart phone)
  - Data check so double registrations are avoided

Systematic disease recording

in general

- Started before 1985 in Norway, Sweden and Finland
- Started in Denmark in 1990 in cooperation between Danish Cattle Federation and the Danish Veterinary Society
- After 2006 registration has started in e.g. Austria, Canada, France, UK…..

Claw disease registration

- Denmark, Sweden, Finland and Norway
  - Joint definition of claw disease traits
  - Joint registration system (touch screen ready 2010)
  - Data stored on four national databases


NAV

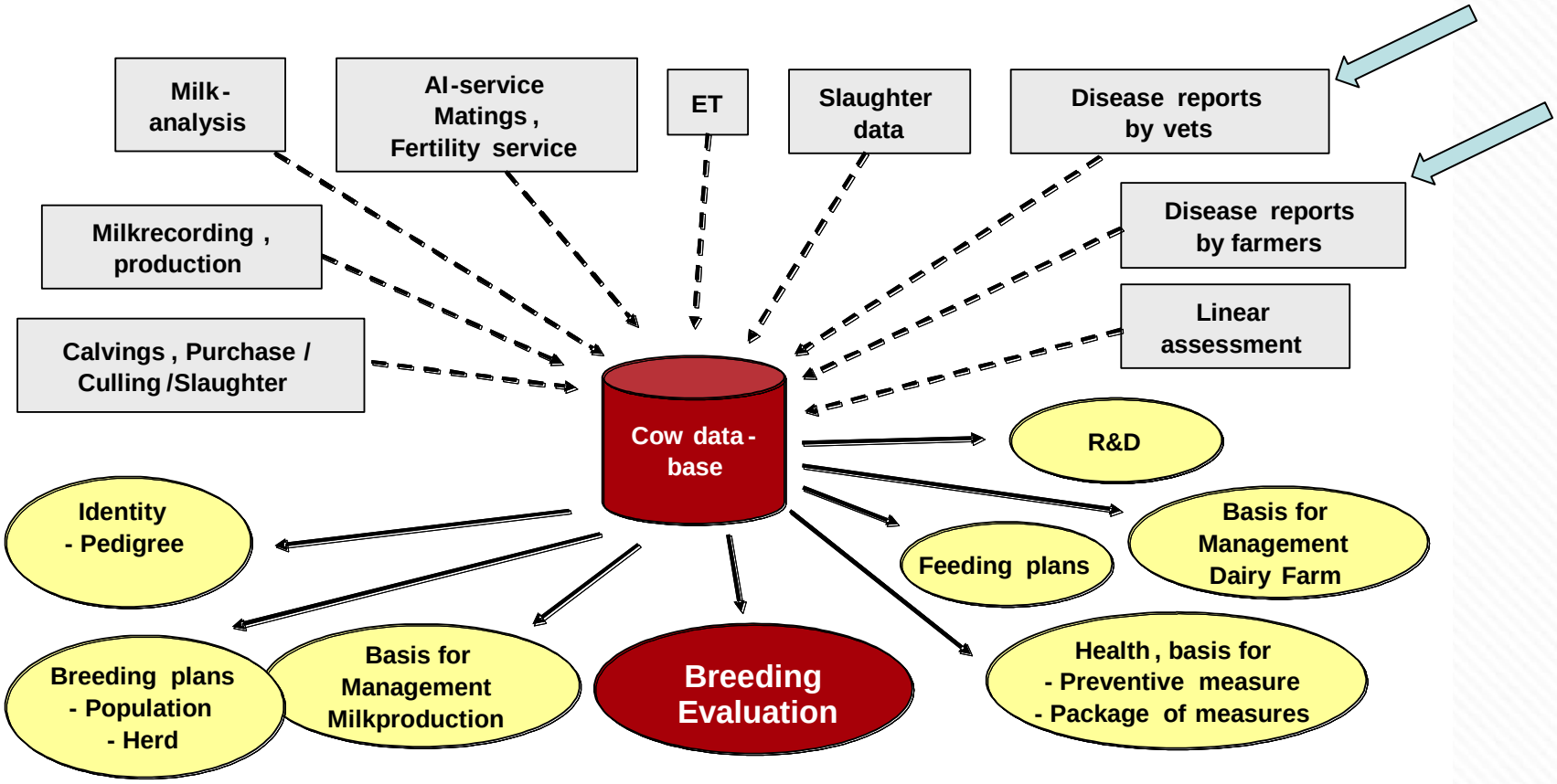
Building a disease registration system

- Recording can improve management today and ensure accuracy of selection for tomorrow
- Made possible by ongoing farmers' participation
- Nordic claw recording is a nice example – started in 2010 – today 40% of all Danish herds participate

Disease recording

- Recordings can be made by
  - Herd managers
  - Veterinarians
  - Claw trimmers

Cow database



Data flow in relation to central database

Disease recording system

- More than 80 different disease codes are used to describe the diagnoses
- For breeding purposes the codes are pooled within four categories:
  - Udder diseases
  - Reproductive diseases
  - Digestive and metabolic diseases
  - Feet and leg diseases

Traits used in EBV udder health

- Udder health breeding goal traits:
  - Clinical mastitis day -15 to 50 1st lact
  - Clinical mastitis day 50 to 305 1st lact
  - Clinical mastitis day -15 to 150 2nd lact
  - Clinical mastitis day -15 to 150 3rd lact

EBV udder health

- Udder health indicator traits
  - TestDay SCC 1-3 lactation
  - UA Fore udder attachment
  - UD Udder depth

Udder health
Genetic parameters

- Clinical mastitis show a substantial genetic variation
- Heritabilities
  - Clinical mastitis 4%
  - SCC 13%
  - Udder conformation 25%

Udder health

Genetic parameters

- Genetic correlations:
  - CM different lactations 0.70-0.95
  - CM-SCC 0.60
  - CM udder conformation 0.35-0.50

Udder health

Reliability (r_{IA}^2)

- Udder health in theory
  - Based on CM - max 100%
  - Based on SCC – max 36% (r_g^2)
- Udder health in practice (Nordic countries)
  - 40% first proof same time as production
  - 65-75% based on 1st lact daughters

Effect of EBV for udder health

Grouped sires after EBV for udder health	Percentage of daughters with mastitis	
	1st parity	3rd parity
TOP5 (poorest)	21.7%	28.9%
TOP4	18.3%	26.0%
TOP3 (mean)	15.3%	23.8%
TOP2	13.9%	21.0%
TOP1 (best)	10.7%	17.0%

Other health traits

Diagnoses

- Reproductive diseases
- Metabolic and digestive diseases
- Feet and leg diseases (vet treatments)

1-3 lactation used in EBV

Other health traits

Genetic parameters/reliabilities

- Heritabilities 1-3%
- Moderate positive correlations among disease traits
- Based on 1st batch daughters r_{IA}^2 55-65%

Claw diseases

Infection related

- Dermatitis
- Heel Horn Erosion
- Skin Proliferation

Heritabilities 4-6%

Metabolic related

- Sole Haemorrhage
- Sole Ulcer
- White line separation+ double sole

Heritabilities 2-6%

Malformation

- Cork screw claws

Genetic correlations

Between	Range
Infection related traits	0.3-0.9
Feed related traits	0.2-0.9

Between	Range
Infection related and **feed** related traits	-0.2 to 0.3

Between	Range
Same trait in different lactations	0.80-0.99

Claw trait definition and EBV

- 7 traits per lactation
- 3 lactations

} 21 traits

Economical weights used to calculate EBV for Claw health

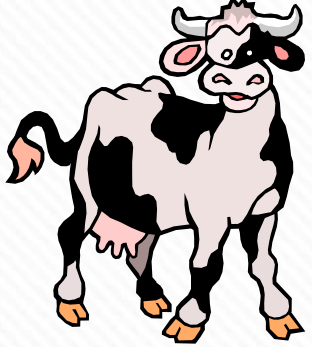
Correlations between EBVs for health

	Claw health	Resistance Other diseases
Udder health	0.20	0.29
Claw health	-	0.25

Birth year 2005-07

Positive correlations between health traits!

Total Merit Index



- Economically important traits should be included to ensure maximum progress (and balanced progress)
- More efficient to strive for progress in many traits simultaneously – compared to large gains in few traits with other negative consequences

Correlation between NTM and single traits

Birth year 2005-2007

Yield	0.62
Growth	0.12
Fertility	0.42
Birth index	0.34
Calving index	0.25
Udder health	0.48
Other diseases	0.46
Claw health	0.34
Feet and legs	0.23
Mammary system	0.19
Milk ability	0.04
Temperament	0.03
Longevity	0.68

1.00 = selection for yield only

Positive response all traits

+25 NTM - Genetic progress per traits

Holstein	Correlation	+25 NTM units response single traits
Yield	**0.62**	**15.5 index units**
Growth	0.12	3.0
Fertility	0.42	6.3
Birth index	0.34	3.0
Calving index	0.25	8.5
Udder health	**0.48**	**12.0**
Other diseases	**0.46**	**11.5**
Claw health	**0.34**	**8.5**
Feet and legs	0.23	5.8
Mammary system	0.19	4.8
Milk ability	0.04	1.0
Temperament	0.03	0.8
Longevity	0.68	17.0

10 years efficient cattle breeding

+25 NTM units give

Trait	Kg
Milk, kg	496
Fat, kg	26.7
Protein, kg	18.9

10 years efficient cattle breeding

+25 NTM units give

Trait	Mastitis cases	Other disease, cases
1st lact	- 5.8day0-50 - 3.4day50-305	-6.2
2nd lact	- 8.0	-6.2
3rd lact	- 9.2	-8.2

Without NTM – frequency of mastitis and other diseases will increase!!!

Does a TMI (NTM) fit all farms?

- Economic values have to be the best guess on future production circumstances (5-10 years ahead)
- A breeding goal has to be jointly for the population/breed

Does NTM fit all farms?

- The production circumstances might vary a little among farms – different management level and production circumstances
- NTM will ensure a balanced genetic progress - the functional/health traits have effect in all herds!

Effect of NTM selection in practice on health traits

Within herd comparisons

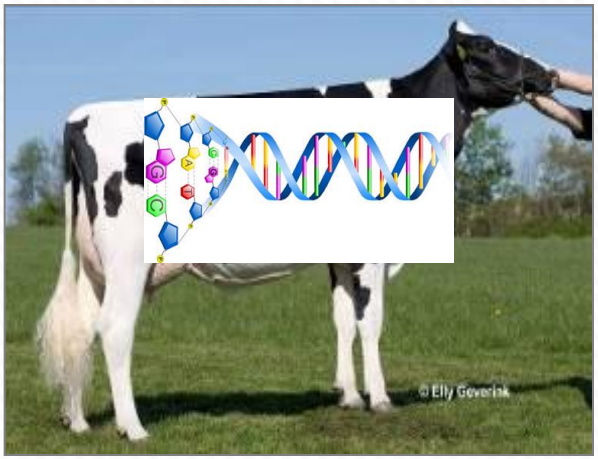
- 60 large Danish herds
  - Cows born 2006-2007
  - Split in 2 groups according to NTM in 2008
    - I NTM under herd mean
    - II NTM over herd mean
  - Looked at differences in performance in 2009-2011

TMI selection has positive effect on health traits

Difference NTM group over average versus NTM group below average within herd. Total 60 Danish herds

Trait	1st lact, kg	2nd lact, kg
Protein	+13 kg	+12 kg
First to last insemination	- 5 day	- 3 days
Longevity	+ 5%	+ 8%
Mastitis	- 2%	- 2%

Health traits and genomic selection

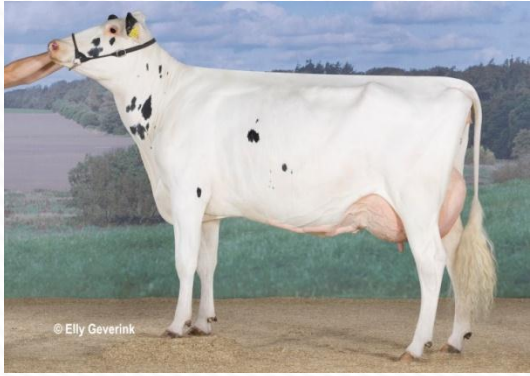


Genomic selection and breeding goal

- The economic values are the same with and without genomic selection

- But the response we get in the different traits will be different

Reliabilities EBV/GEBV



- Traditional
  - Bulls: protein >> health traits
  - Females: protein >>> health traits
- Genomic Selection
  - Bulls: protein > health traits
  - Females: protein > health traits

Relative genetic progress

Breeding scheme	Total response	Response protein	Functional traits
Progeny test	100	100	100
GS + Progeny test	129	113	161
GS	201	169	273

Buch et al 2011

Reliability GEBV for health traits

- Key factors
  - A good registration system
  - A lot of reference animals with information
  - A young registration system require genotyped females to be effective
    - E.g. Nordic countries have 2,000 reference bulls for claw health but >20,000 for production traits

Conclusion - health traits

- Economical important
- Large genetic variation
- Positive genetic correlation between health traits
- Including in breeding goal important to maximize genetic progress - balanced genetic progress

Conclusion - health traits

- Genomic selection can give a more balanced genetic progress
- The underlying “gold” is the farmers own accurate registrations of health traits – a good registration system is essential