

# Dutch Milk Genomics Initiative 2004-2008



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# Application of Milk Genomics Information

## ■ Selection in cows

Cheese cow

CLA cow



# Application of Milk Genomics Information

## ■ Selection (differentiation) in bulls

Cheese cow

CLA cow

S	Naam	Afstamming	NWI	INET	I	Lvd
★	Bertil	Willis x Jocko	215	185	109	191
★	Fiction	O-Man x Ronald	215	126	111	253
★	Butembo	Abim x Jocko	215	126	111	328
★	Win 395	Willis x Jocko	215	126	108	421
★	Surprise	Dustin x Luxemburg	202	97	106	396
★	Barclay	Bailey x Webster	191	134	109	312
★	Canvas	Sparta x Celsius	190	214	107	329
★	Holman	O Man x Mtoto	190	69	108	511
★	Paramount	Jocko x Fatal	177	141	111	337

# Application of Milk Genomics Information

- Selection of bulls for breeding program
  - ▶ Cheese breeding program
  - ▶ CLA breeding program
  - ▶ .....

# Dutch Milk Genomics Initiative

Aim: Identify opportunities to **exploit natural genetic variation** to improve milk quality characteristics

## ■ Milk quality:

- ▶ Milk-fat composition
- ▶ Milk-protein composition

## ■ Improve:

- ▶ Technological efficiency (production of cheese, butter)
- ▶ Innovative dairy products (e.g. promoting human health)

## ■ Exploit natural genetic variation:

- ▶ Marker assisted differentiation
- ▶ Marker assisted selection

# Acknowledgements

Wageningen University

Farmers

## ■ Dairy Science & Technology

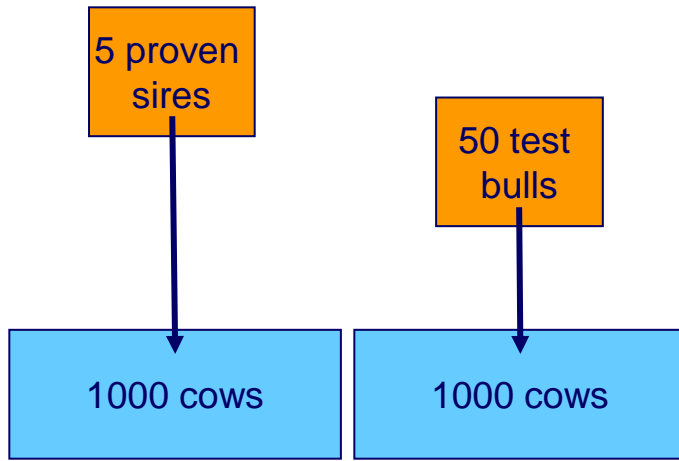
- ▶ Jeroen Heck
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# Resource population



2000 Holstein Friesian cows

First lactation

On 400 farms

Database:

- Pedigree
- Cow data (birth date, calving date, ...)
- Milk Production Records
- Mastitis
- Farm details (diet, management, ...)

Biobank:

- Per cow: 3 milk samples,  
1 blood sample (DNA)
- Per sire: 1 semen sample (DNA)

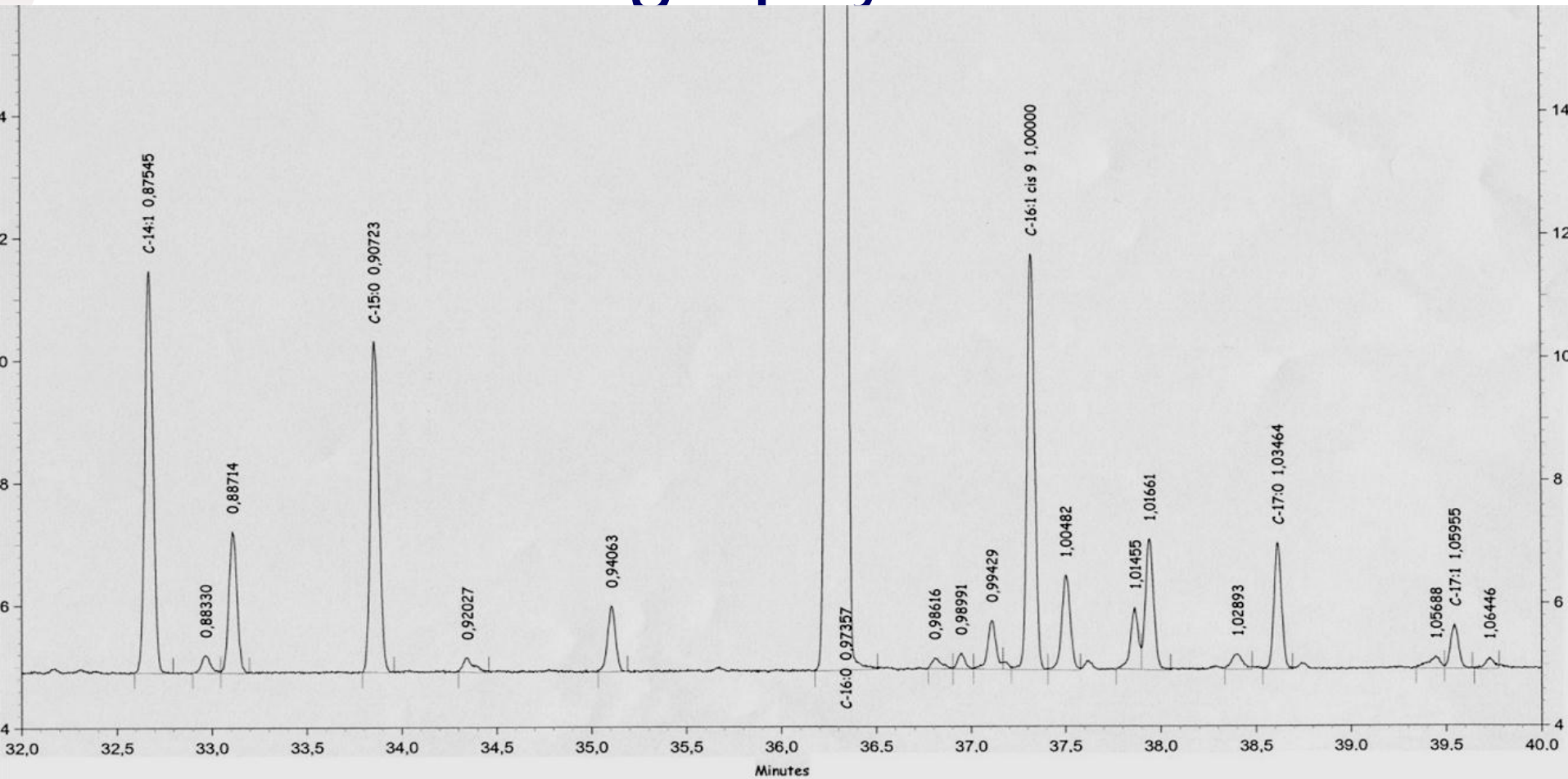
# Phenotypes: milk composition

- Milk production records
  - ▶ Kg milk, % fat, % protein, % lactose, pH, urea, ...
- Detailed milk-fat composition
- Detailed milk-protein composition





# Detailed milk-fat composition: Gas chromatography



# Detailed milk-fat composition

- Variation among cows?
- Sources of variation?
  - ▶ Genetic ( $h^2$ )
  - ▶ Farm (herd)



# Milk-fat composition

Trait	Mean (% w/w)	CV (%)	$h^2$	Gen/Herd
C4:0-C12:0	14.2	9	0.59	1.7
C14:0	11.6	8	0.59	2.8
C16:0	32.6	9	0.43	1.1
C18:0	8.7	16	0.23	1.0
C18 unsat	21.6	11	0.26	0.6
Sat/Unsat	2.8	13	0.28	0.7

# Detailed milk-fat composition

## Conclusions:

- Considerable genetic variation
- Moderate to high heritability
- Genetics more important than herd for short chain fatty acids

# Detailed milk-protein composition

- Variation among cows?
- Sources of variation?
  - ▶ Genetic ( $h^2$ )
  - ▶ Farm (herd)



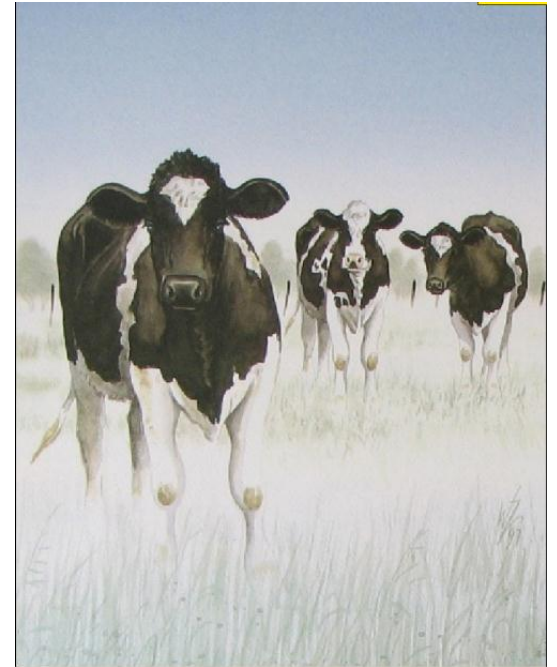
# Milk-protein composition

<b>Trait</b>	<b>Mean (% w/w)</b>	<b>CV (%)</b>	<b><math>h^2</math></b>	<b>Gen/Herd</b>
<b><math>\alpha_{S1}</math>-casein</b>	<b>33.6</b>	<b>5</b>	<b>0.47</b>	<b>3.5</b>
<b><math>\alpha_{S2}</math>-casein</b>	<b>10.1</b>	<b>14</b>	<b>0.73</b>	<b>4.7</b>
<b><math>\beta</math>-casein</b>	<b>27.2</b>	<b>6</b>	<b>0.25</b>	<b>1.4</b>
<b><math>\kappa</math>-casein</b>	<b>8.4</b>	<b>14</b>	<b>0.64</b>	<b>4.9</b>
<b><math>\alpha</math>-lactalbumin</b>	<b>2.4</b>	<b>13</b>	<b>0.55</b>	<b>2.8</b>
<b><math>\beta</math> -lactoglobulin</b>	<b>8.3</b>	<b>14</b>	<b>0.80</b>	<b>13.9</b>

# Detailed milk-protein composition

## Conclusions:

- Considerable genetic variation
- High heritability for most proteins
- Genetics more important than herd



# Molecular basis of genetic variation

## Identification of loci:

- Polymorphisms in candidate genes (8 genes)
- QTL mapping using 1300 DNA markers (with 50.000 markers in progress)



# DGAT1: Effects of K232A polymorphism

Trait	AA compared to KK	P-value	R <sup>2</sup> genetic (%)
Fat %	-0.98	<0.001	50
C16:0	-2.52	<0.001	40
C18 unsat	2.12	<0.001	53
CLA	0.05	<0.001	16

Selection of CLA animals

# Beta-Lactoglobuline

Genotype	Casein Index
AA	0
AB	1.46
BB	3.14
P-value	<0.001

Selection of cheese animals

# Conclusions

- Variation in traits
- Part of variation is genetic ( $h^2$  0.2-0.8)
- Genes and QTL regions identified

Can basically be already used for selection of specific animals (cows and bulls)

# Thank you

