

Genetic analyses of principal components of milk mid-infrared spectra from Holstein cows

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August 31, 2023



Why select the milk mid-infrared spectra?

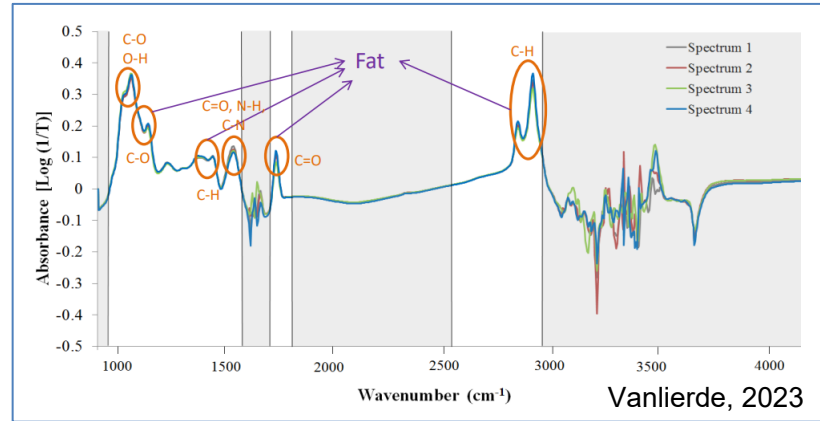
Milk samples test process



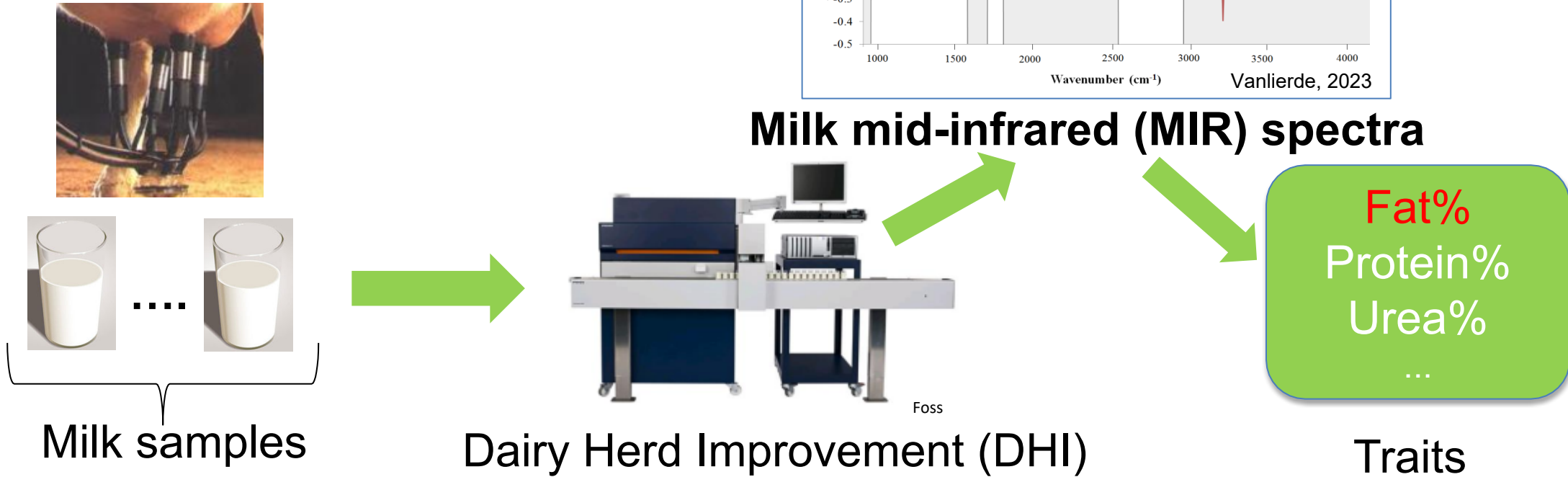


Why select the milk mid-infrared spectra?

Milk samples test process

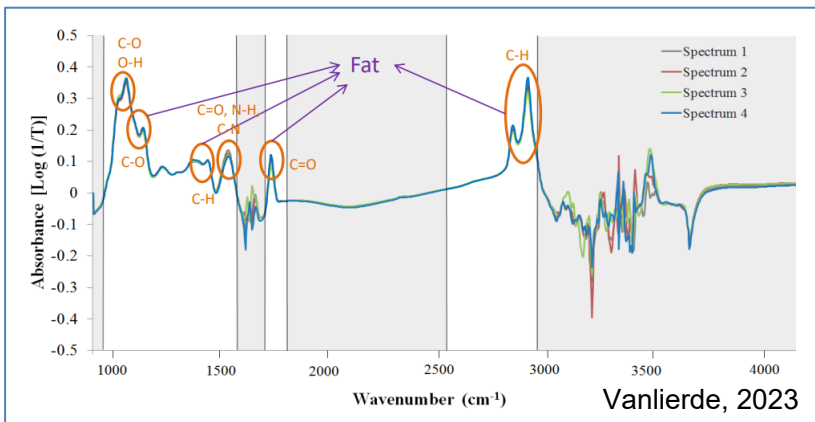


Milk mid-infrared (MIR) spectra





Why select the milk mid-infrared spectra?



Milk mid-infrared (MIR) spectra

Milk or Blood composition

Milk fatty acids (Soyeurt et al., 2006);
Milk/blood β -hydroxybutyrate(BHB), citrate (Grelet et al., 2021);
Milk Vitamin B12 (Duplessis et al., 2021)

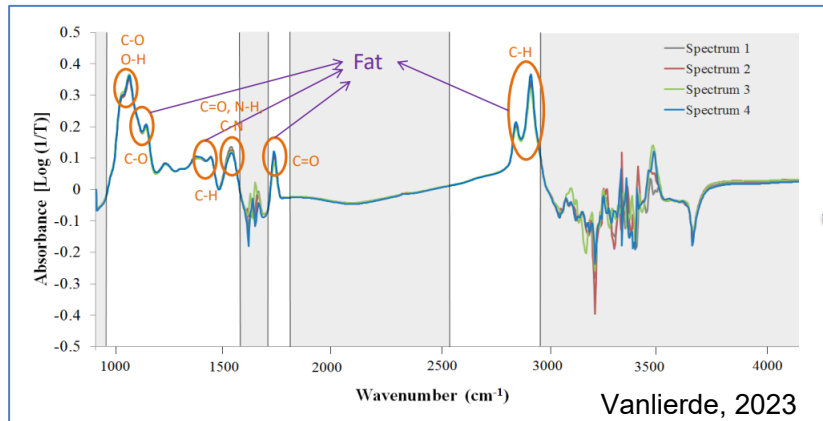
.....

Novel cattle traits

CH₄ (Dehareng et al., 2012; Vanlierde et al., 2020);
Pregnancy (Brand et al., 2021; Tiplady et al., 2022);
Tuberculosis (Denholm et al., 2020)

.....

Traditional way using milk mid-infrared spectra



Milk mid-infrared (MIR) spectra

Multiple Calibration

Multiple traits

Milk fatty acids

Milk/blood BHB

Citrate

Milk Vitamin B12

CH₄

Pregnancy

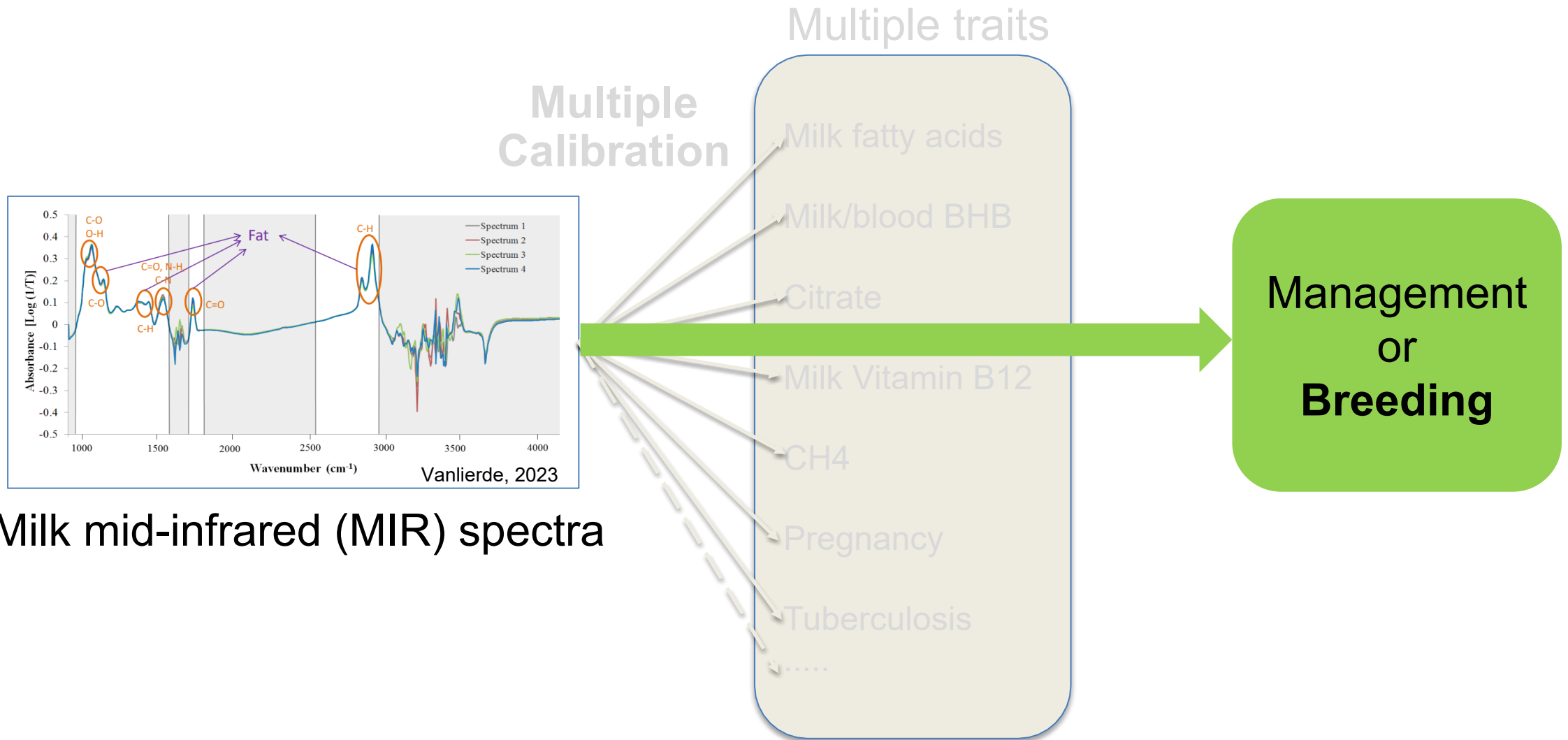
Tuberculosis

.....

Management
or
Breeding



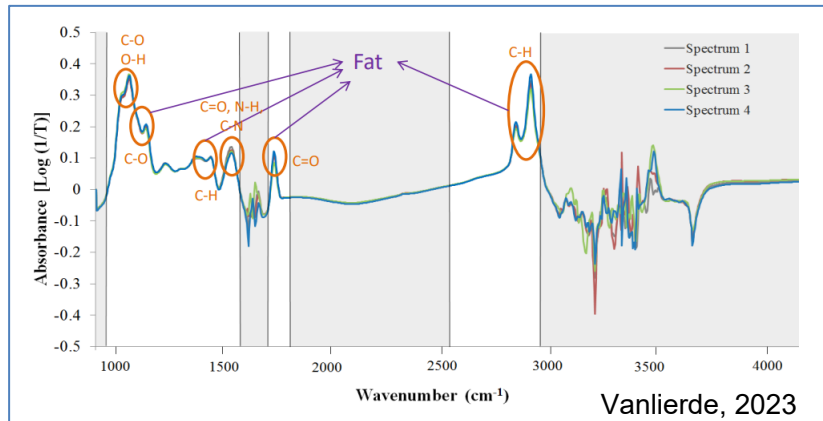
Novel way using milk mid-infrared spectra



Milk mid-infrared (MIR) spectra



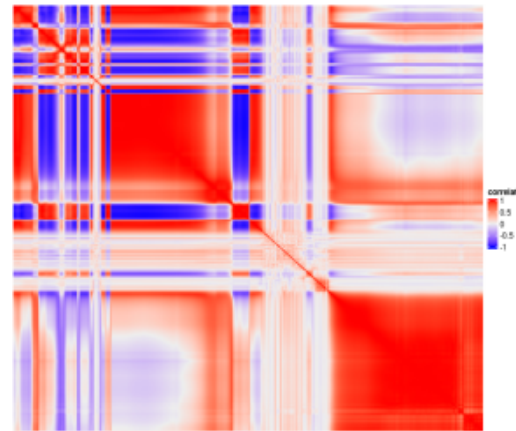
Features of milk infrared spectra



Milk infrared spectra

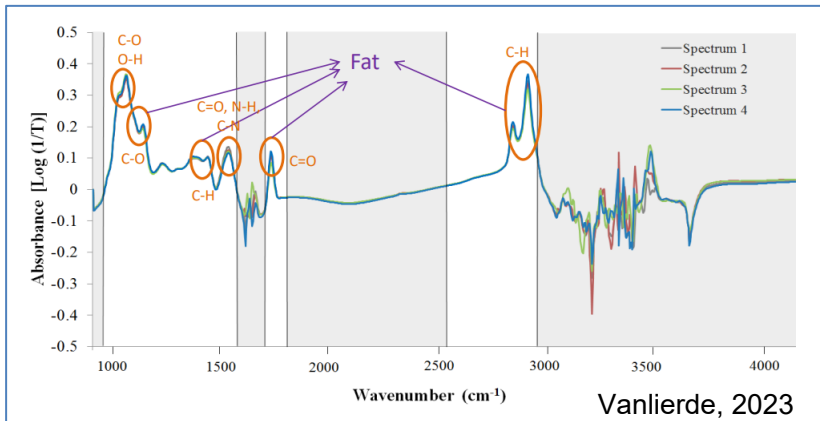
~ 1,000 Wavenumbers

High correlations





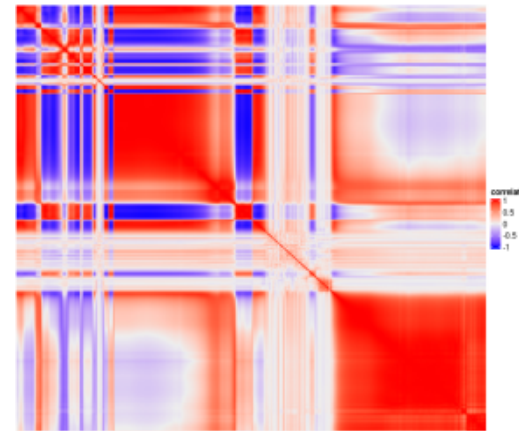
Genetic analysis of milk infrared spectra



Milk infrared spectra

~ 1,000 Wavenumbers

High correlations

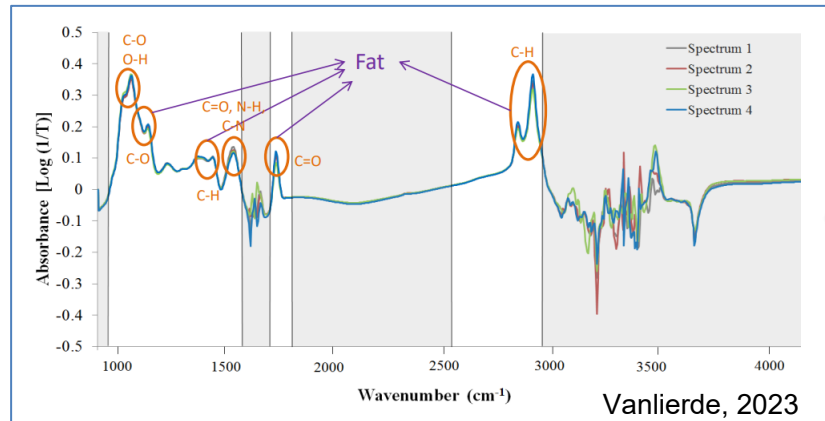


Genetic analysis

Multiple single-trait models

Principal component analysis (PCA) +
Multiple single-trait models (PCs)

Genetic analysis of milk infrared spectra



Milk infrared spectra

Principal component analysis (PCA)

Phenotypic variance

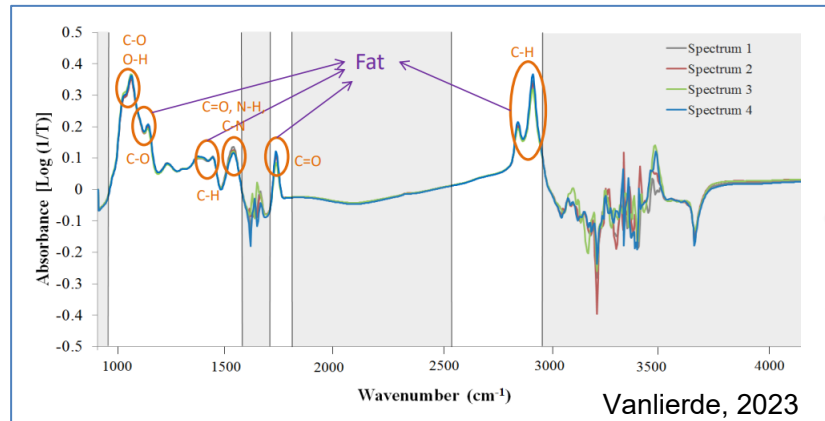
First 46 PCs (**99.03%**, Soyeurt et al., 2010)
First 8 PCs (**99%**, Bonfatti et al., 2017)

Principal components (PCs)

Multiple single-trait models

Genetic analysis

Question



Milk infrared spectra

Principal component analysis (PCA)

Phenotypic variance

First 46 PCs (**99.03%**, Soyeurt et al., 2010)
First 8 PCs (**99%**, Bonfatti et al., 2017)

Number of principal components (PCs) ?

Multiple single-trait models

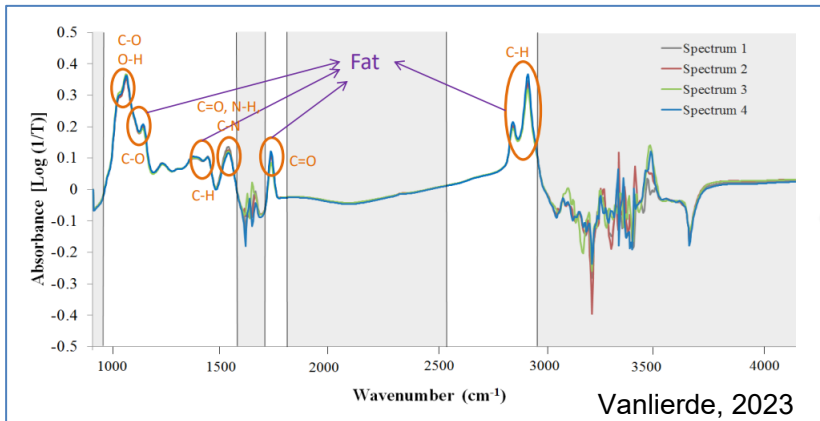
Genetic analysis

represent



Workflow-1

Principal component analysis (PCA)



Milk mid-infrared (MIR) spectra
(311 Wavenumbers)



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<https://doi.org/10.3168/jds.2019-17717>

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Predicting milk mid-infrared spectra from first-parity Holstein cows using a test-day mixed model with the perspective of herd management

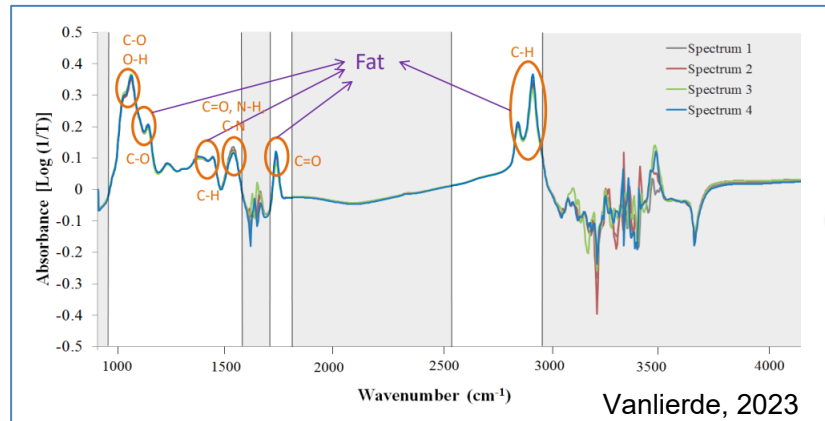
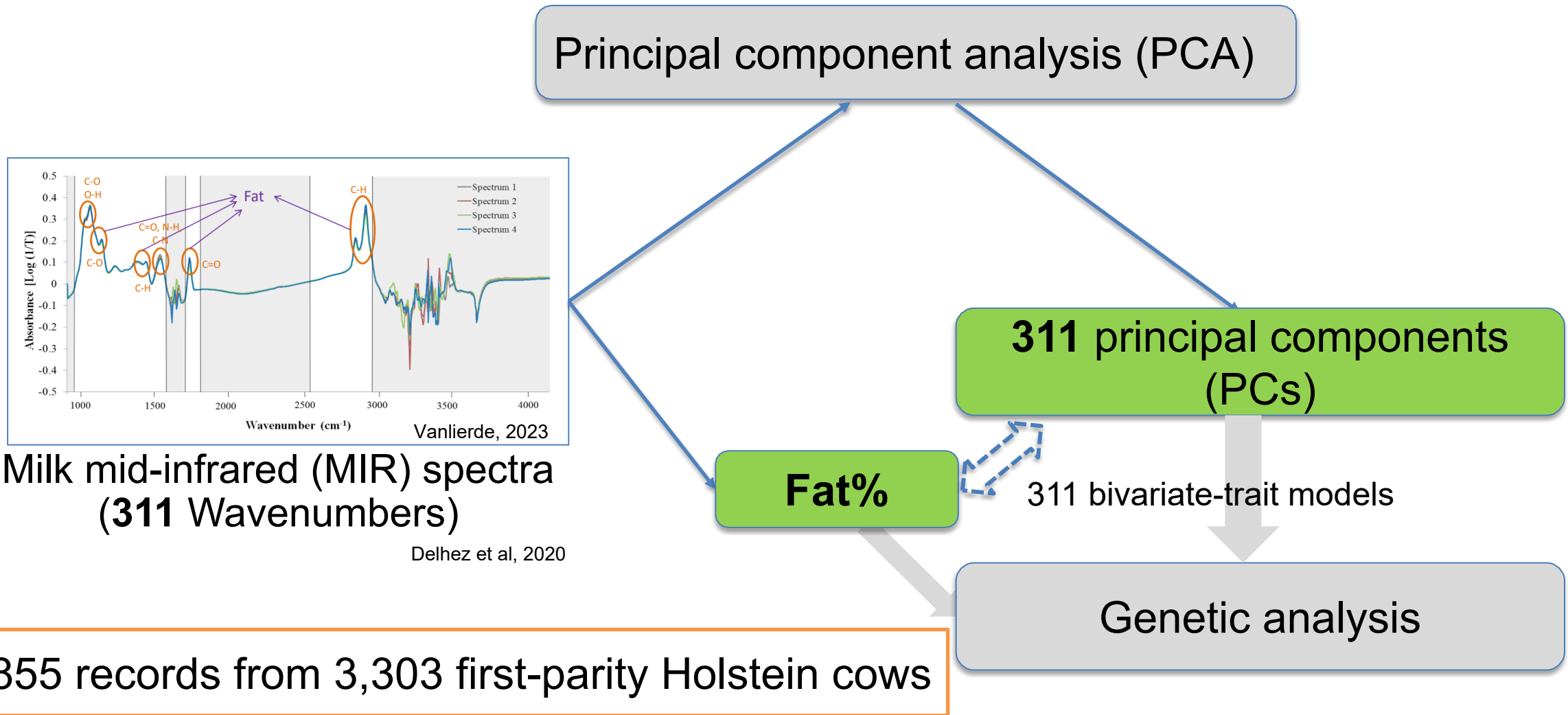
P. Delhez,^{1,2*} F. Colinet,² S. Vanderick,² C. Bertozzi,³ N. Gengler,² and H. Soyeurt²

311 principal components
(PCs)

311 single-trait models

Genetic analysis

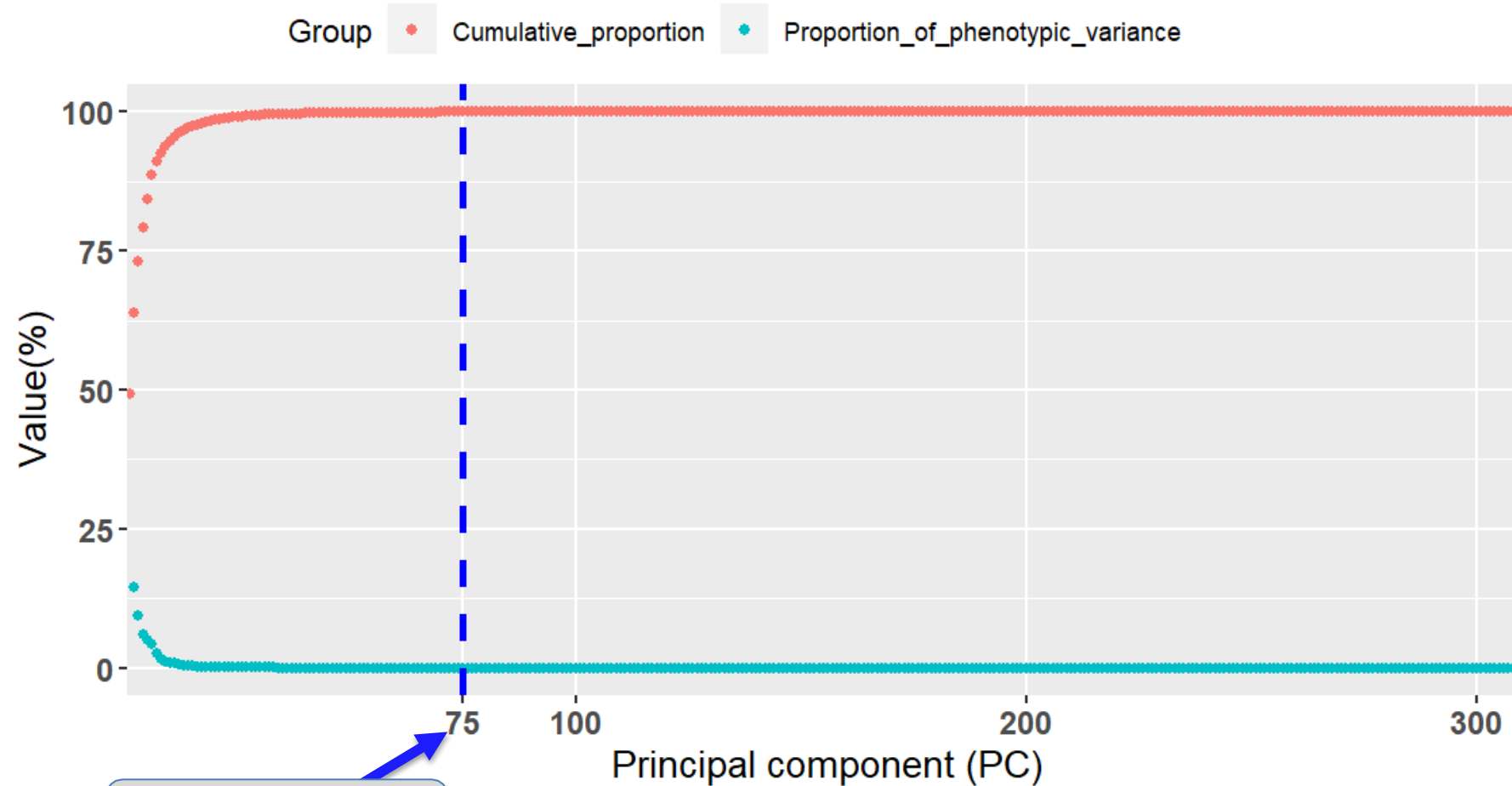
Workflow-2



Results - (1)



311 PCs explained **total phenotypic** variance

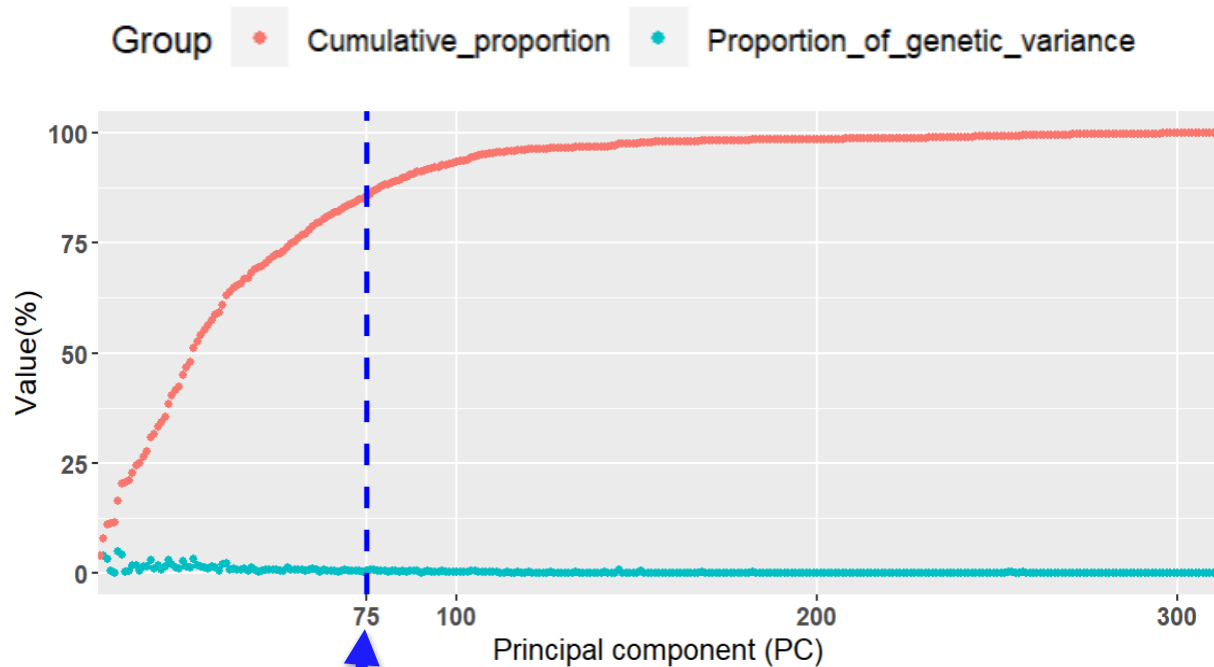


> 99.99%

Results - (2)



311 PCs explained **total genetic** variance



= 85.54%

311 principal components (PCs)

311 single-trait models

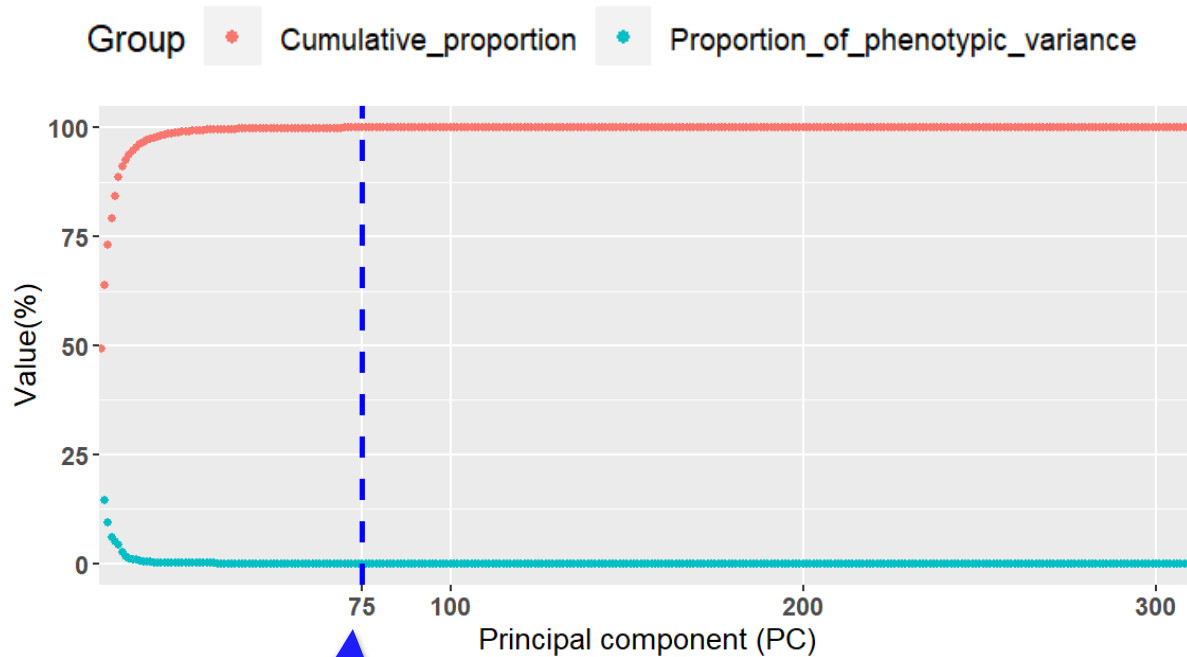
Genetic analysis

$$\frac{\text{Genetic variance of each PC}}{\sum_1^{311} \text{genetic variances}} \times 100$$

Results - (2)

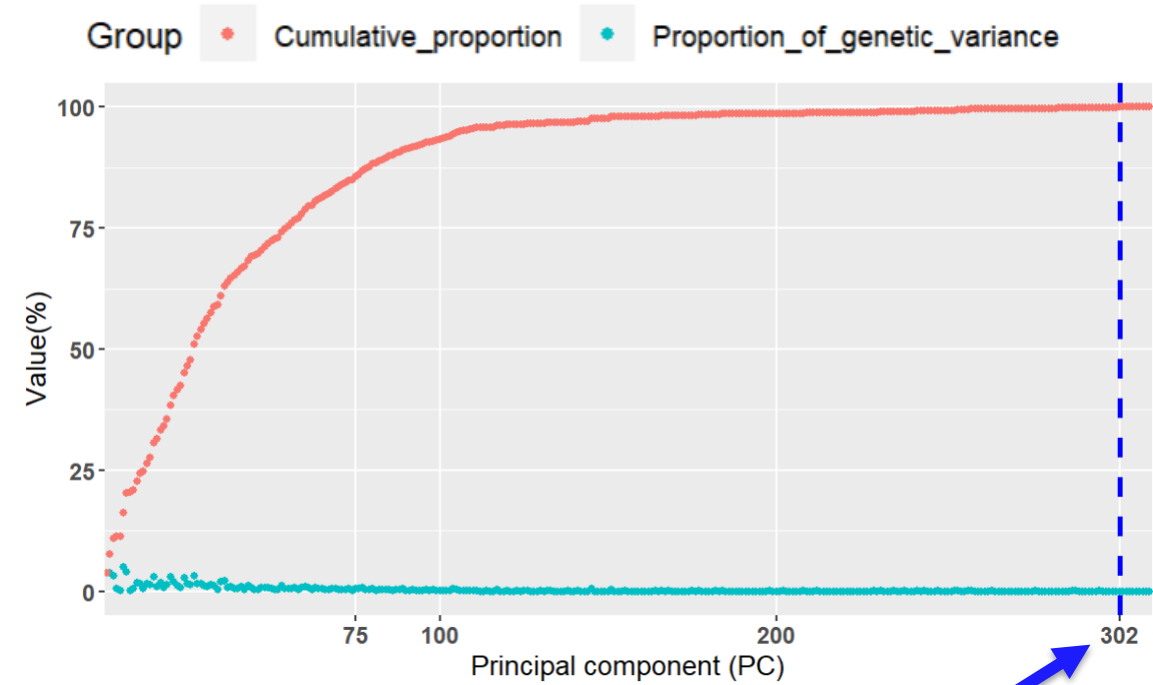


311 PCs explained **total phenotypic** variance



75 PCs > 99.99%

311 PCs explained **total genetic** variance

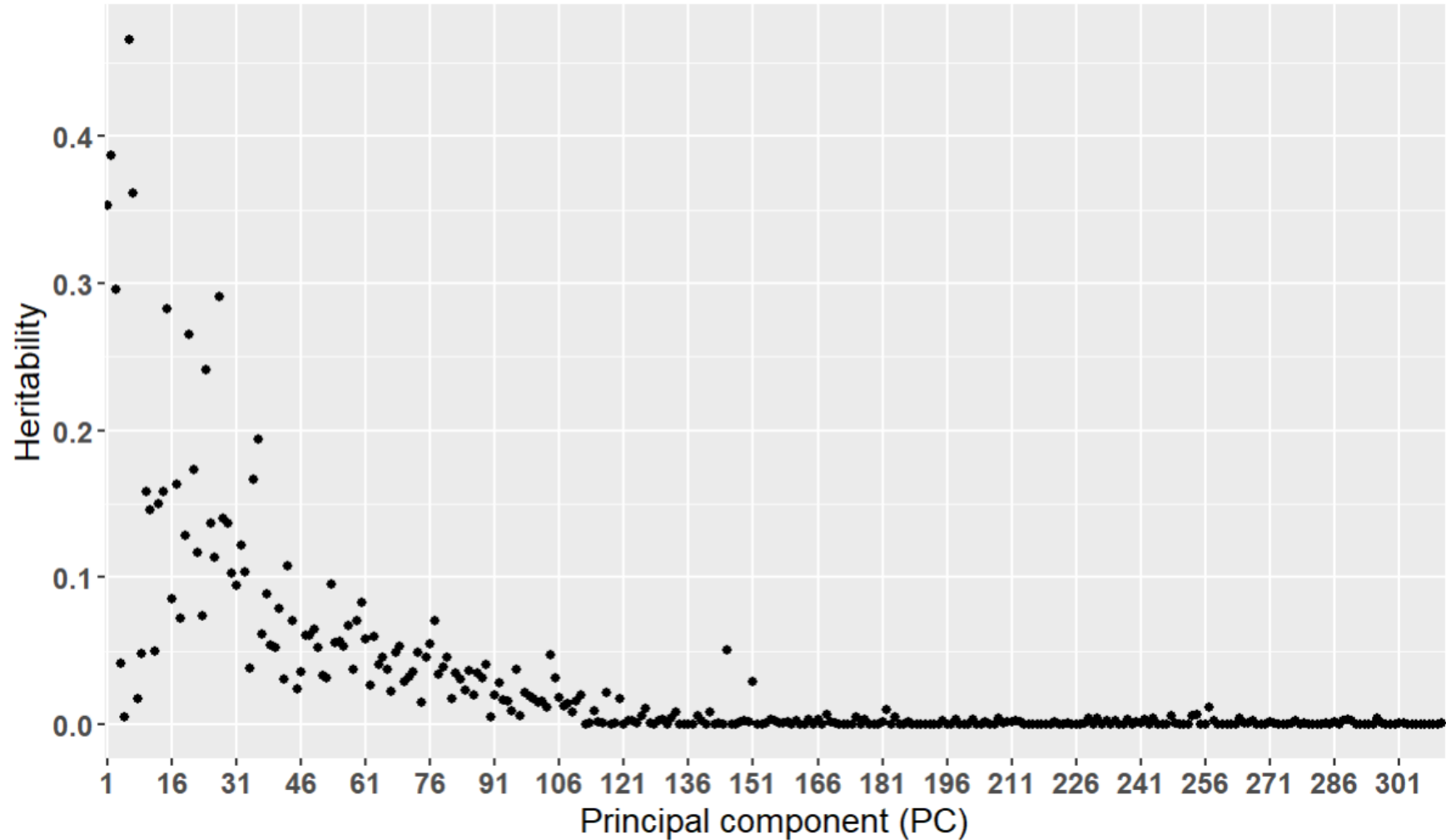


302 PCs > 99.99%

Results - (3)



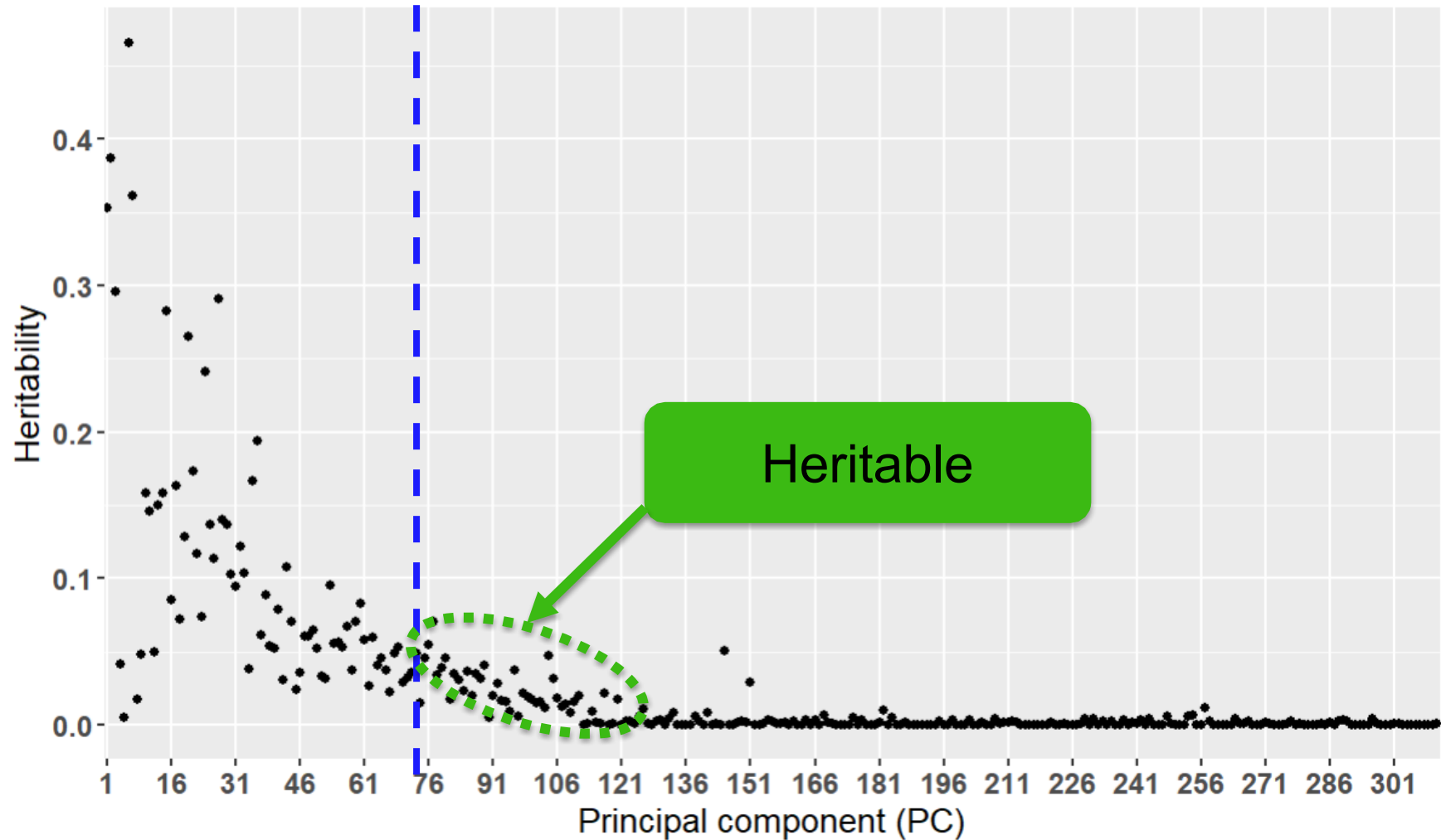
Heritability of 311 PCs: 0.00 — 0.47



Results - (3)



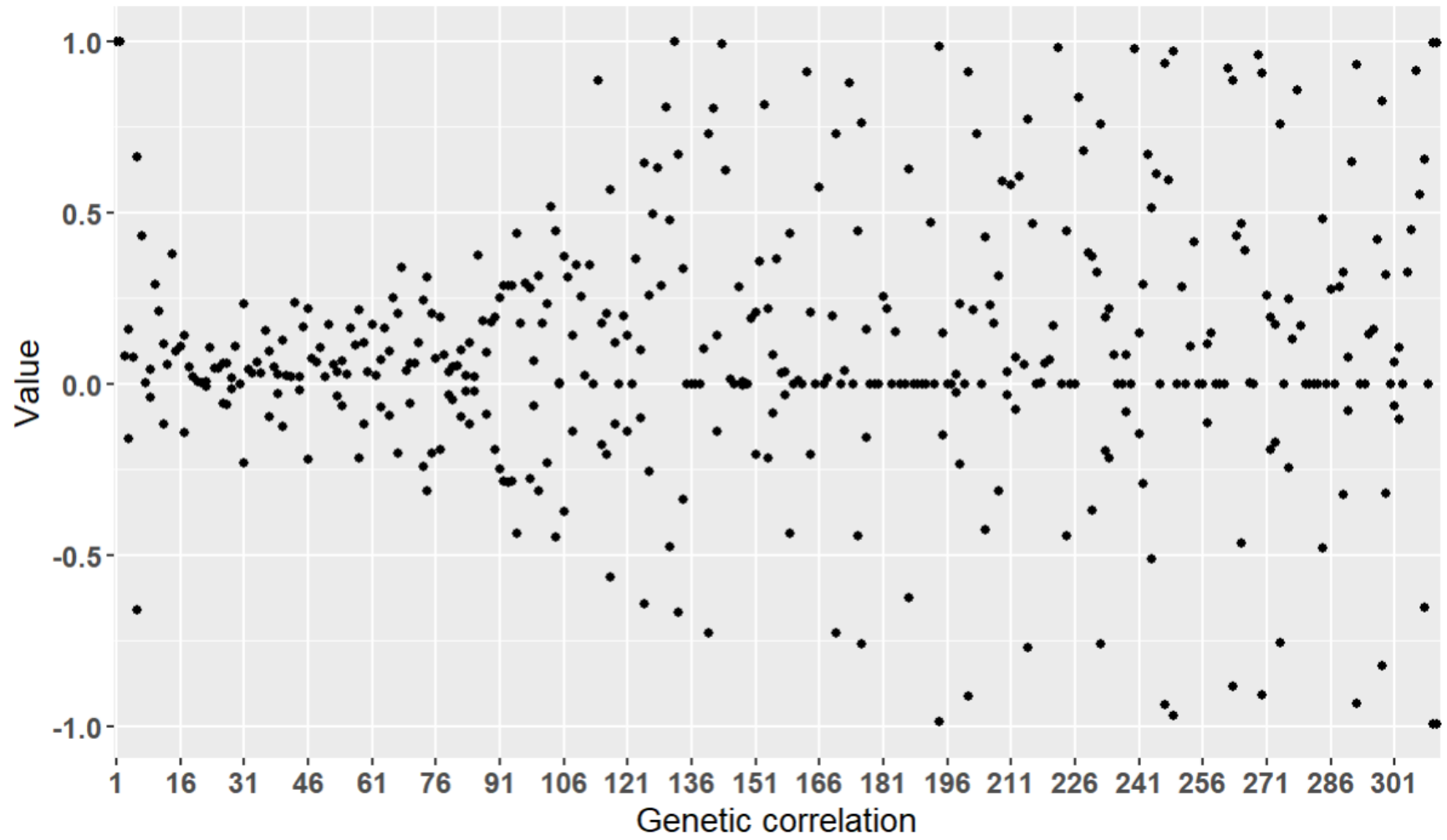
Heritability of 311 PCs: 0.00 — 0.47



Results - (4)



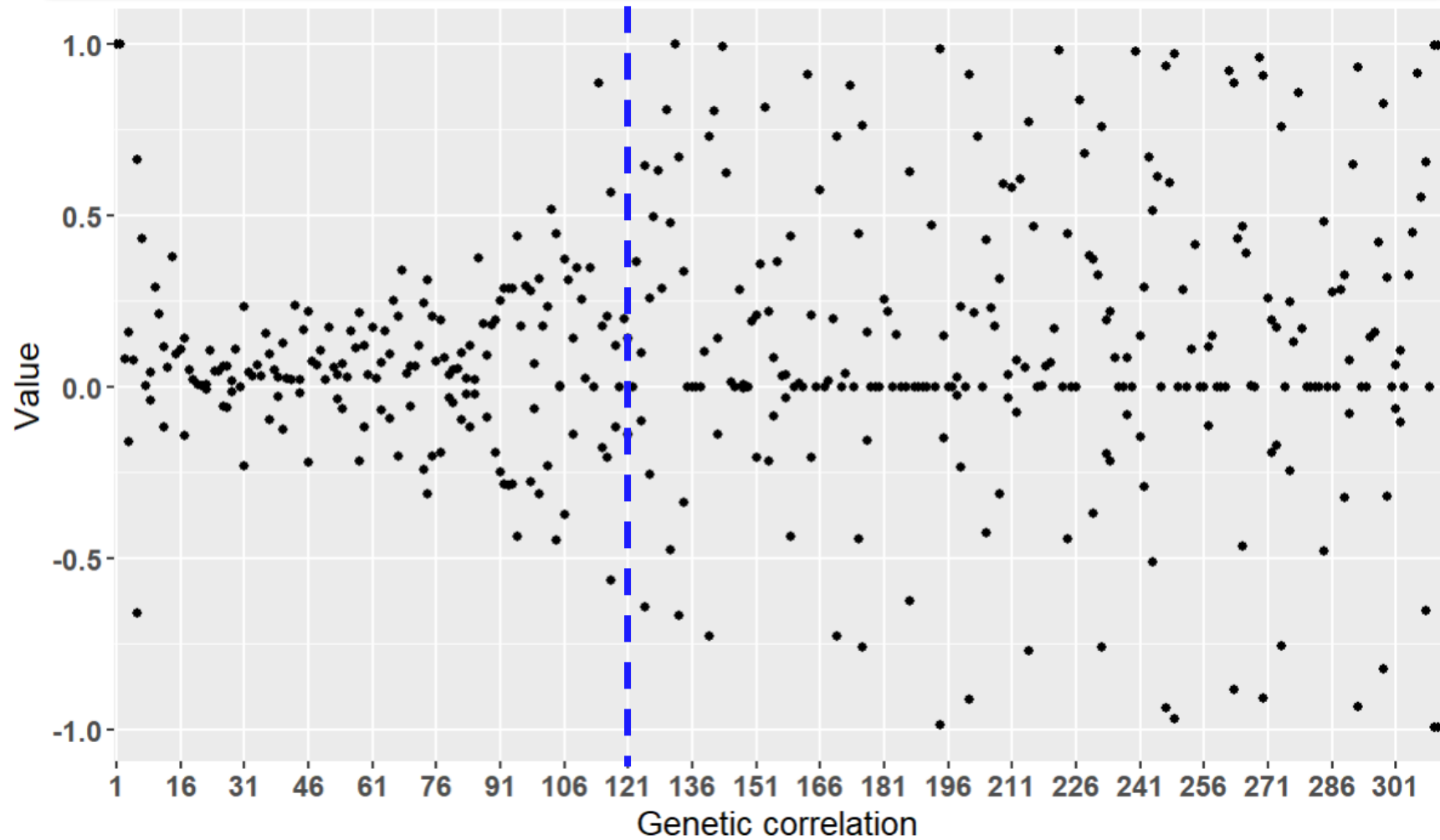
Genetic correlations between 311 PCs and fat%, -1 — 1



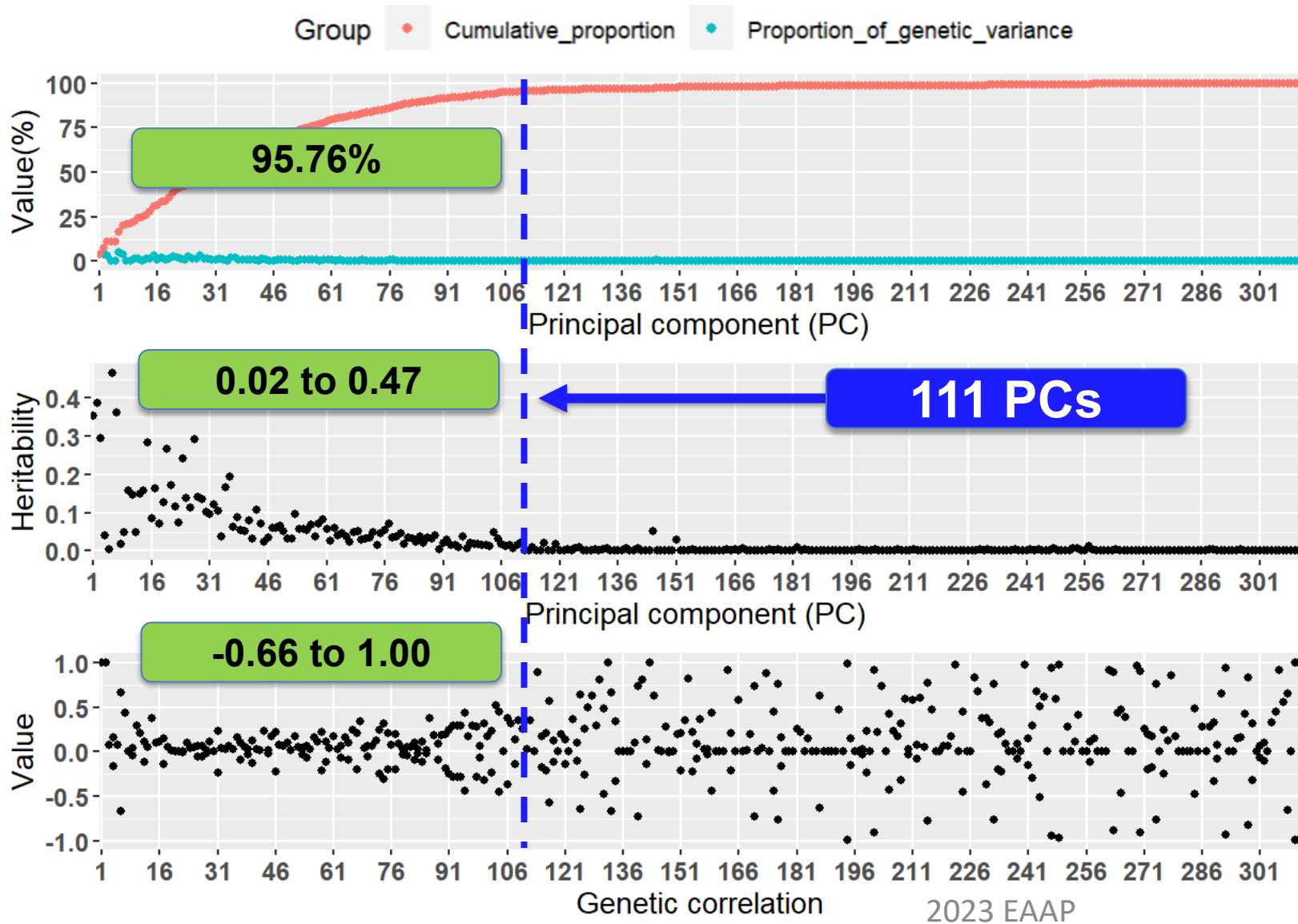
Results - (4)



Genetic correlations between 311 PCs and fat%, -1 — 1



Answer - Number of Principal components (PCs)

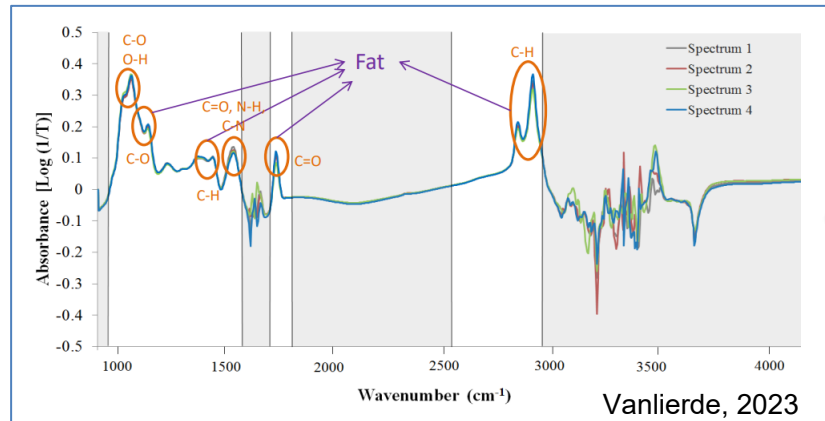


311 PCs explained **total genetic** variance

Heritability of 311 PCs

Genetic correlations between 311 PCs and fat%

Conclusion



Milk mid-infrared (MIR) spectra

Principal component analysis (PCA)

≠ Explain phenotypic variance

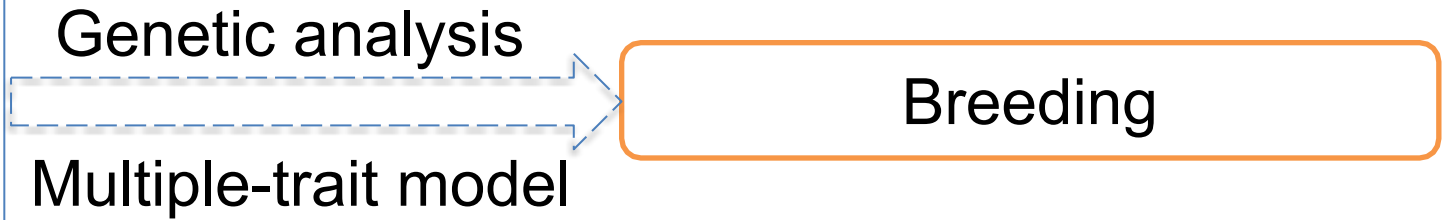
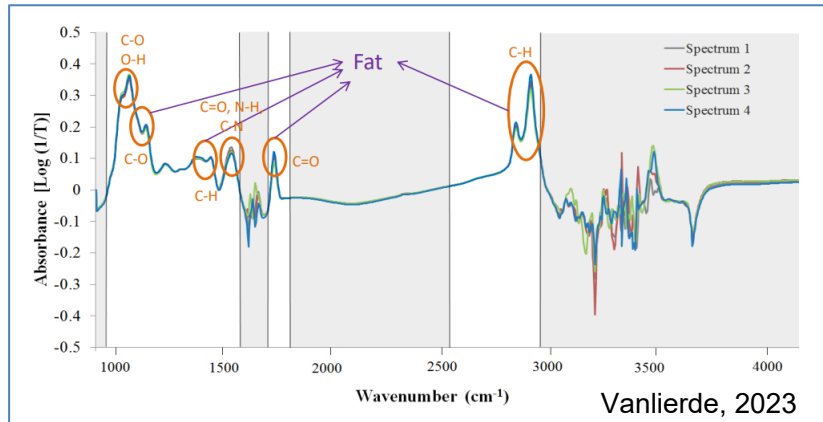
= Explain genetic variance

Number of principal components (PCs)

Breeding



Future



Milk mid-infrared (MIR) spectra



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Co-authors



“Deepselect” project

