Estimation of genetic parameters for production traits in Polish Simmental cattle using a random regression test-day model

Dawid Słomian, Klaudia Gogola, Monika Skarwecka, Kacper Żukowski

Introduction

- Current methodology **has not been updated for a long time**
- Routine genetic evaluation of Polish Simmental cattle is based on a **multi-trait animal model** using the first three lactations
- Modern statistical methods and computing resources allow more detailed modelling of production traits
- Test-day models allow production traits to be analysed across the lactation curve using individual test-day records

Purpose of the study

- Estimate variance components for production traits
- Derive heritability and repeatability from variance components
- Apply estimated genetic parameters to full production data
- Perform first validation of the pedigree BLUP test-day animal model

Material for genetic parameters estimation

	Lactation	Milk	Fat	Protein	SCS	Lactose
Number of records	1	95 038	95 038	95 038	88 256	88 165
Number of records	2	79 301	79 301	79 301	75 119	75 120
Number of records	3	59 443	59 443	59 443	57 371	57 407
Number of animals		13 590	13 590	13 590	13 091	13 091

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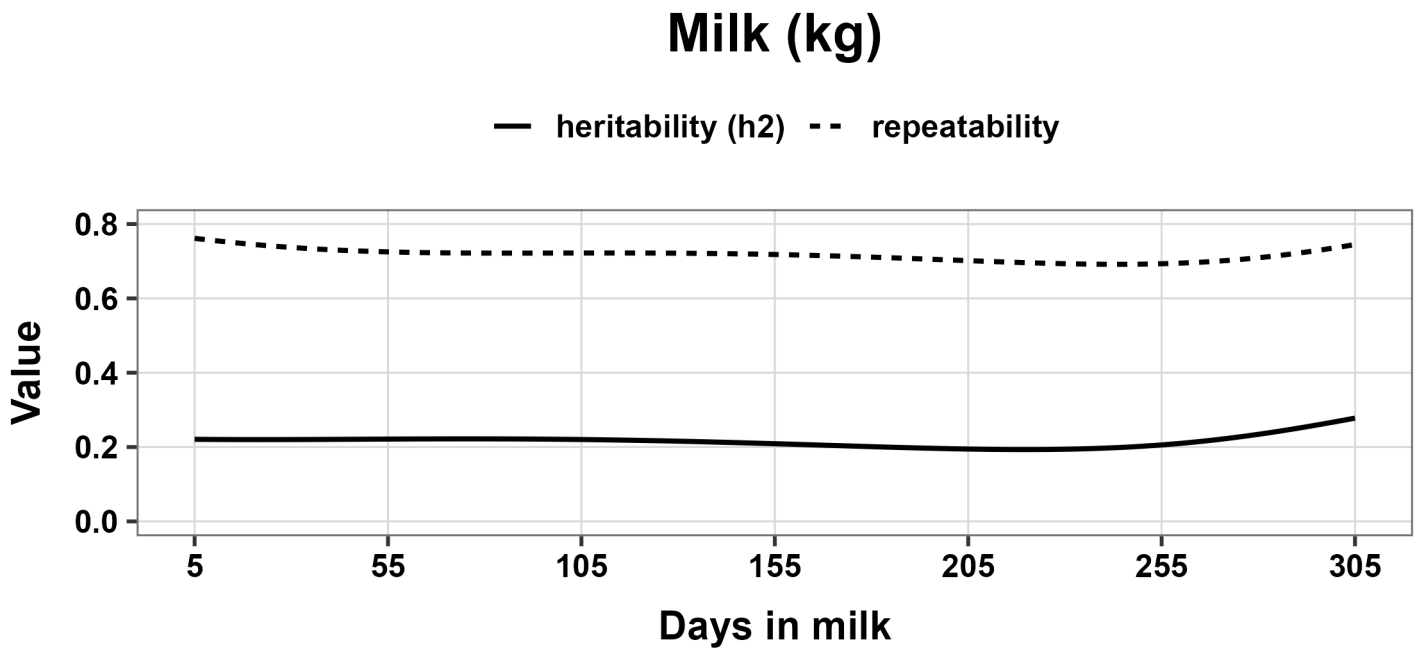
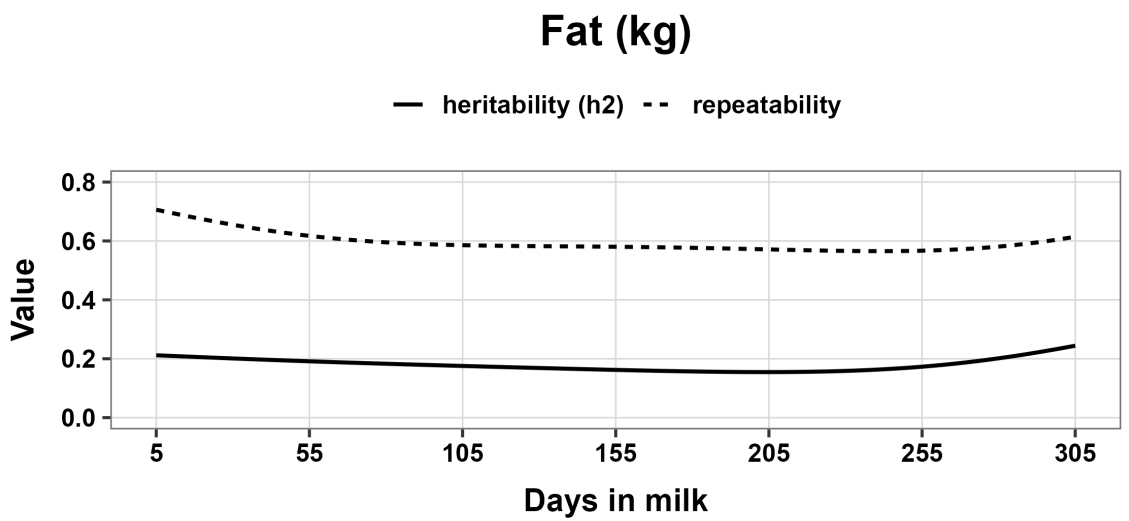
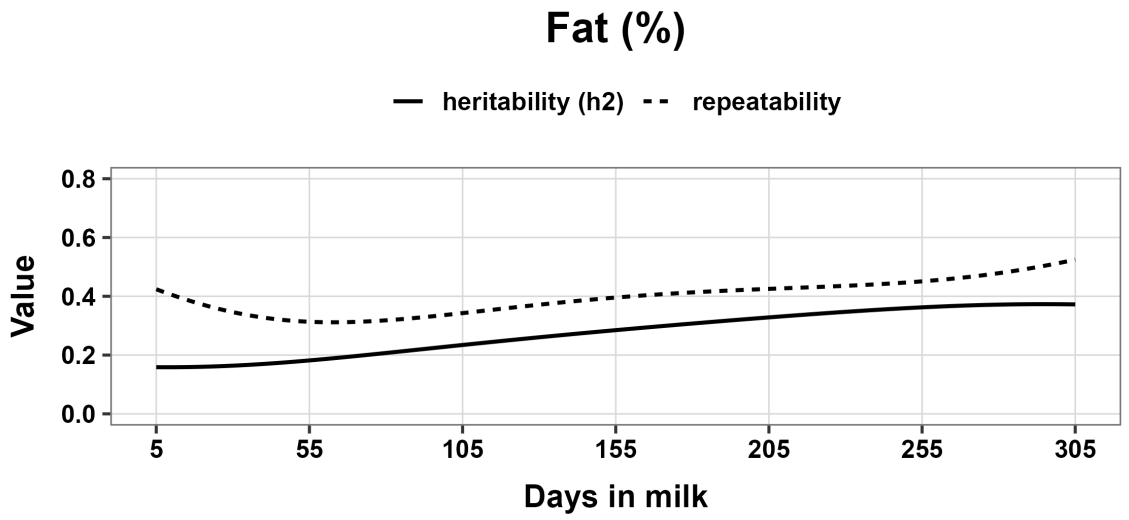
Trait	Heritability Mean	Heritability SD	Repeatability Mean	Repeatability SD
Milk (kg)	0.220	0.016	0.720	0.016

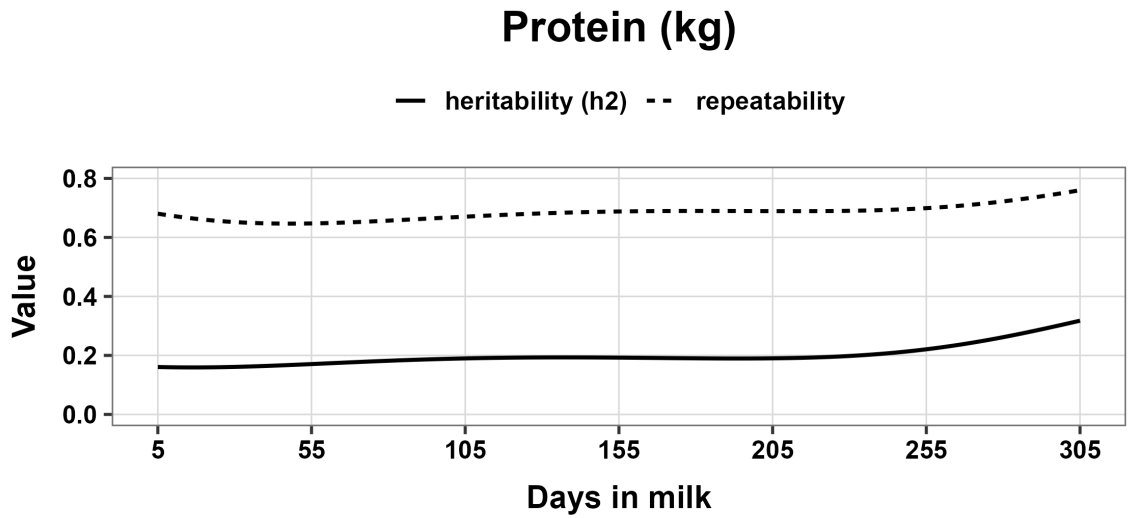


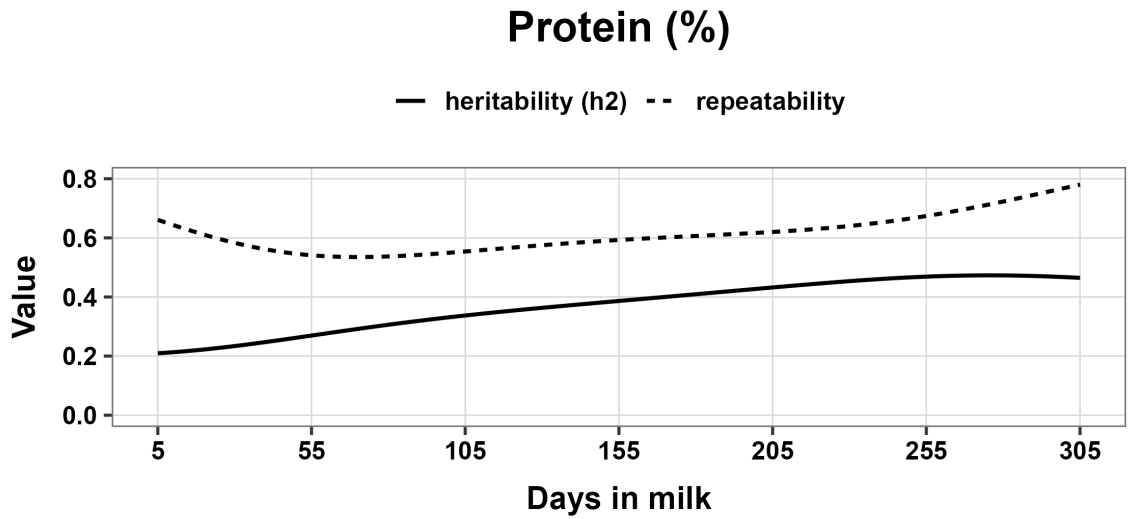
Trait	Heritability Mean	Heritability SD	Repeatability Mean	Repeatability SD
Fat (kg)	0.180	0.021	0.590	0.033
Fat (%)	0.280	0.074	0.400	0.057



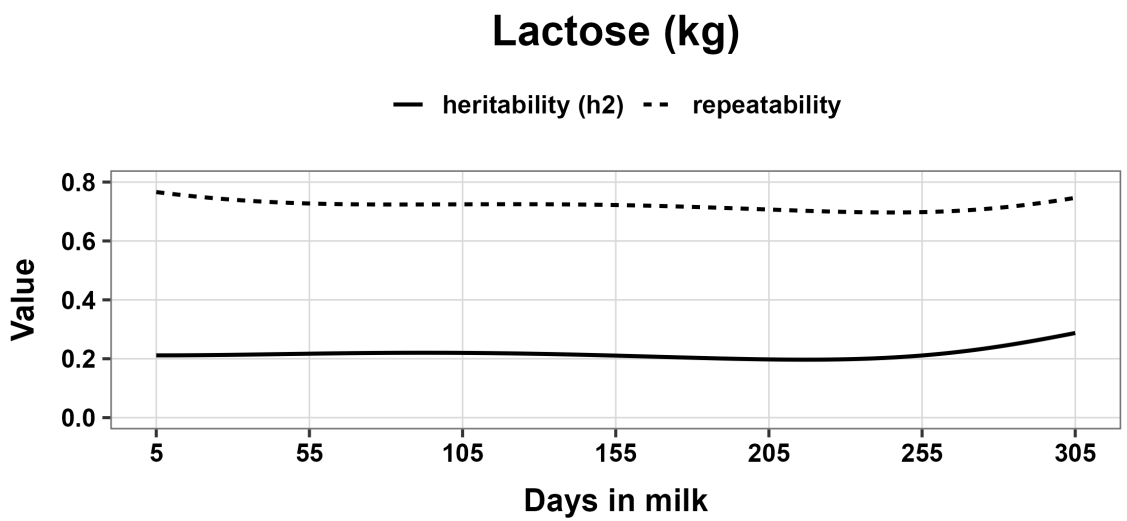


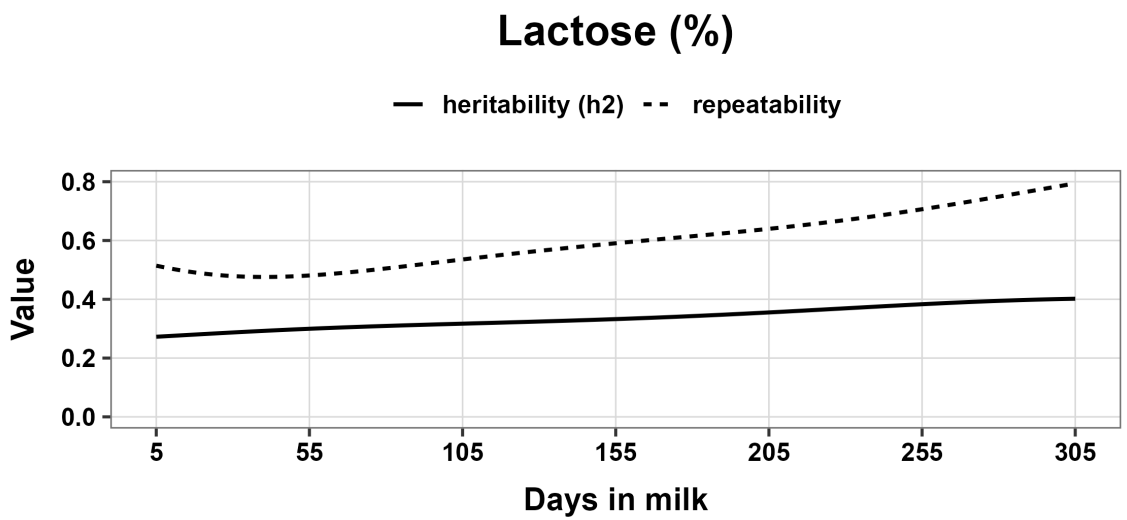
Trait	Heritability Mean	Heritability SD	Repeatability Mean	Repeatability SD
Protein (kg)	0.200	0.034	0.680	0.025
Protein (%)	0.370	0.084	0.610	0.063



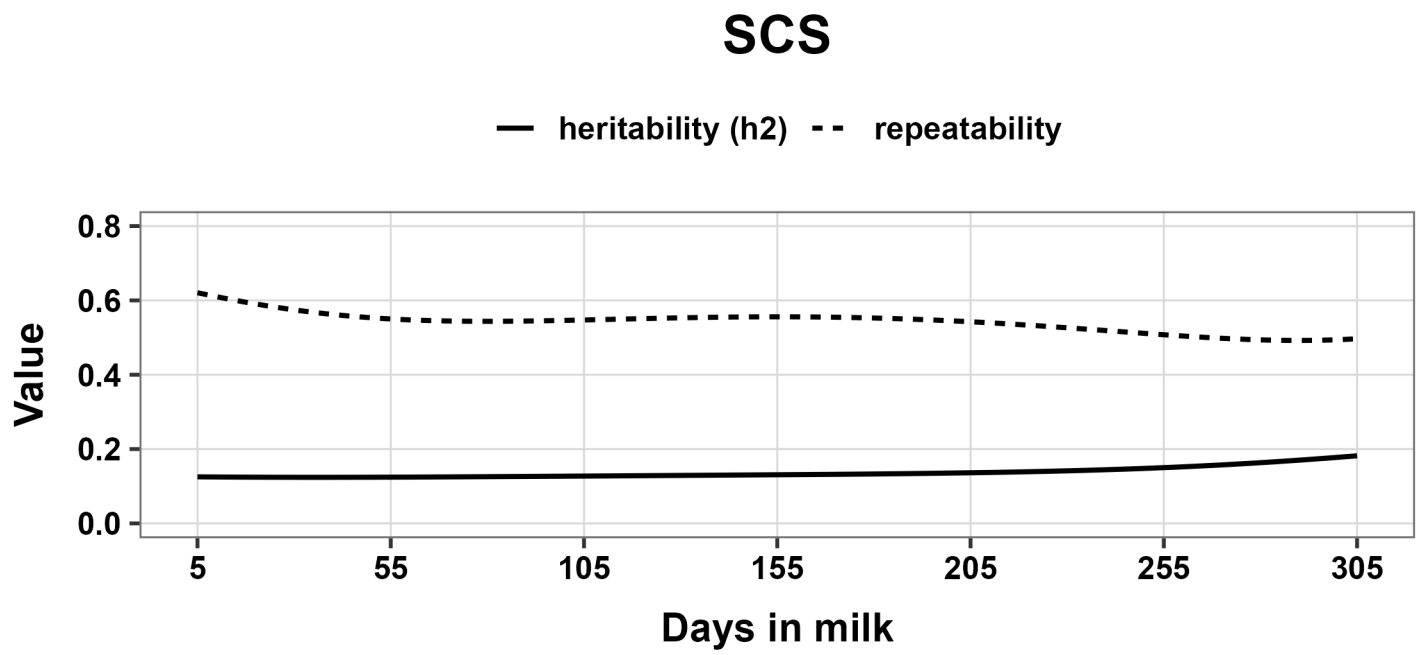


Trait	Heritability Mean	Heritability SD	Repeatability Mean	Repeatability SD
Lactose (kg)	0.220	0.017	0.720	0.015
Lactose (%)	0.340	0.037	0.600	0.094





Trait	Heritability Mean	Heritability SD	Repeatability Mean	Repeatability SD
SCS	0.140	0.014	0.540	0.027



Data for Pedigree BLUP test-day animal model

	Sex	Number of animals
Phenotypic data (Milk, Fat, Protein, Lactose, SCS) FULL	Cows	49,564
Phenotypic data (Milk, Fat, Protein, Lactose, SCS) TRUNCATED	Cows	44,288
Pedigree data	Cows	121,963
	Bulls	61,350

- Truncated dataset prepared for validation
- Youngest animals from the last four years excluded

Pedigree BLUP test-day animal model

$$\boldsymbol{y = Xh + Wf + Vp + Vu + e}$$

y – test-day records for production traits

h – herd-test-date-parity-milking-frequency fixed effect

f – fixed lactation curve effects

p – permanent environmental effects

u – additive genetic effects based on pedigree

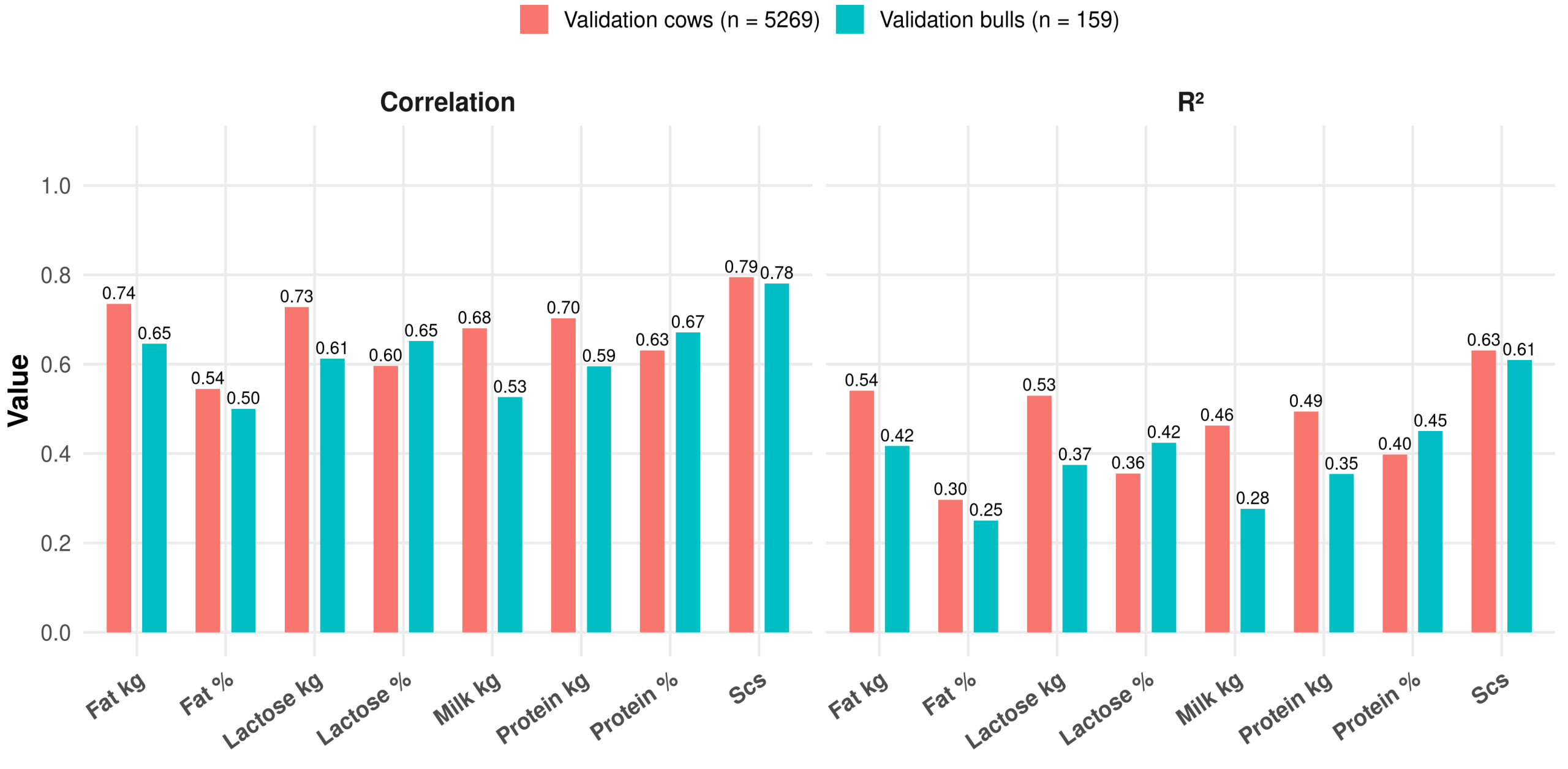
e – residuals

Validation cows – cows removed to create the truncated dataset

Validation bulls – the youngest sires of the validation cows

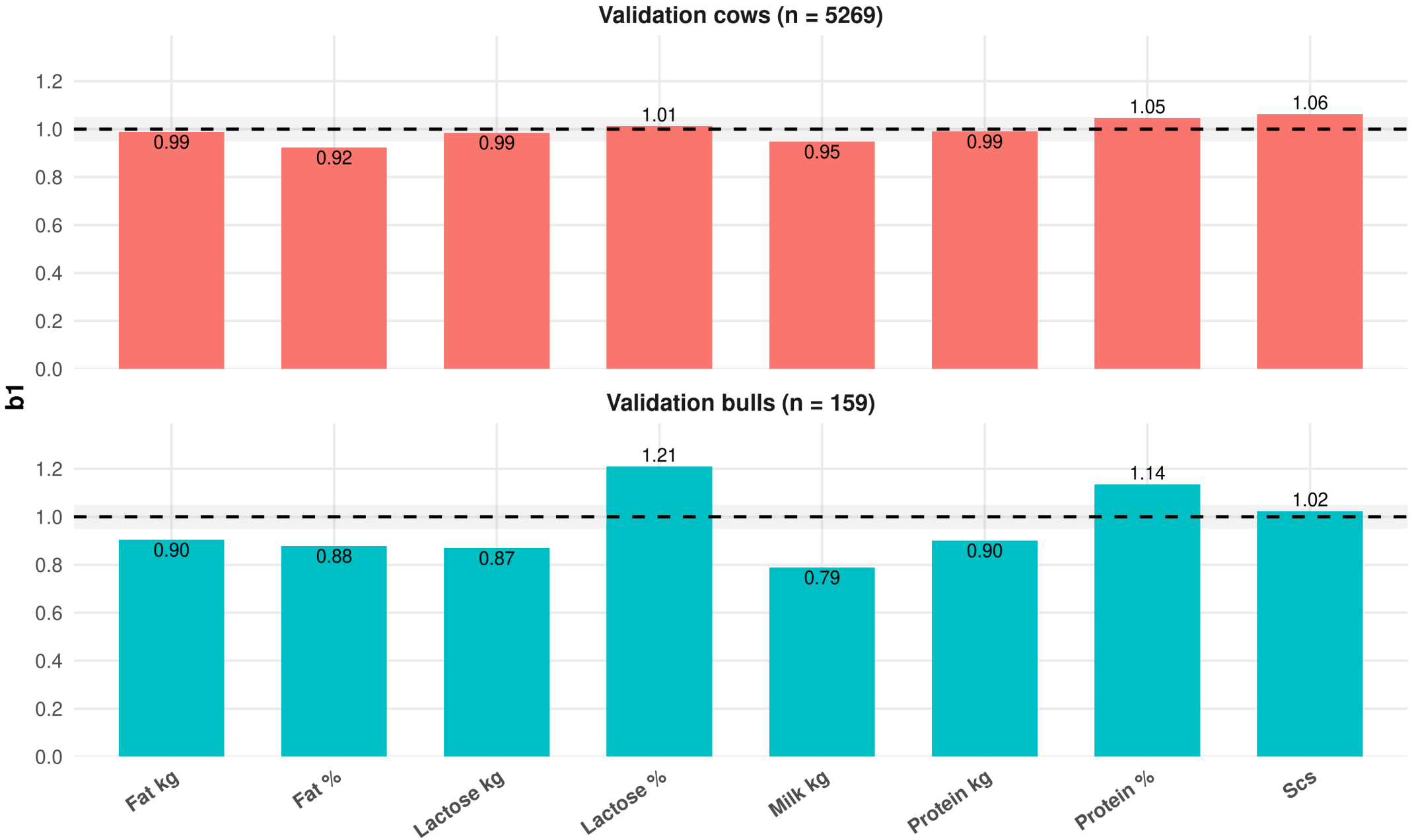
Validation performance

Comparison between cows and validation bulls



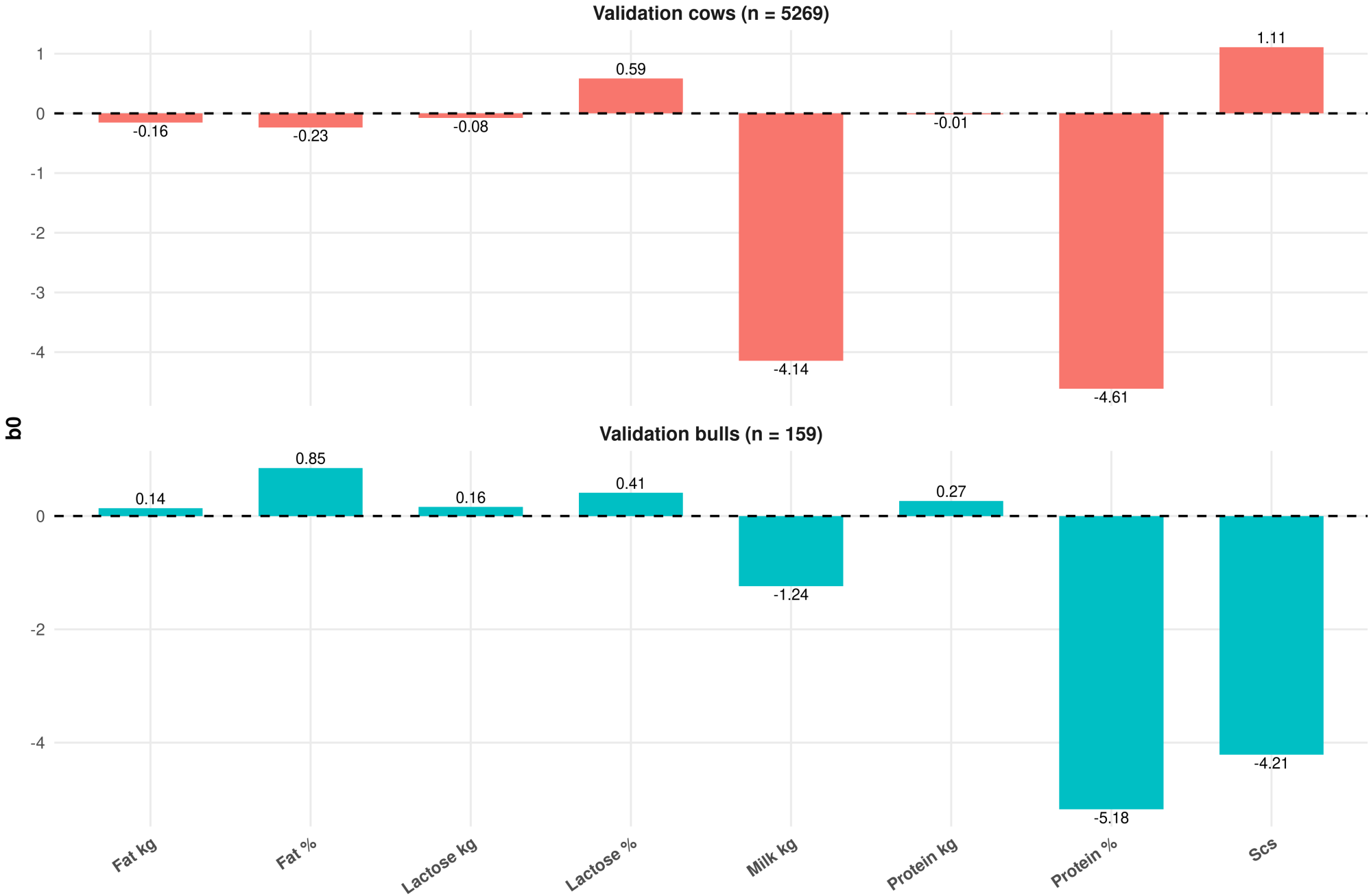
Regression slope (b1)

Ideal value = 1



Regression intercept b0

Values closer to 0 indicate lower prediction bias



Conclusions

- Genetic parameters for production traits were successfully estimated using a pedigree BLUP test-day animal model
- Heritability estimates were within expected ranges
- Repeatability estimates indicated consistent animal performance across test-day records
- First validation results showed satisfactory agreement between full and truncated evaluations
- The obtained results provide a solid basis for further development of test-day models in Polish Simmental cattle

Next steps

- Implementation of a single-step SNP-BLUP test-day model for production traits
- Validation of pedigree BLUP and single-step SNP-BLUP models
- Extension of the approach to other trait groups in Polish Simmental cattle
- A framework for implementing new traits in the Simmental genetic evaluation system is being developed

Acknowledgements

Working group for Simmental genetic evaluation

Dawid Słomian

Kacper Żukowski

Monika Skarwecka

dawid.slomian@iz.edu.pl

Magdalena Jakiel

Klaudia Gogola

Tomasz Piróg

Barbara Kulesza - Żydzik