

# Deregressed genomic breeding values from single-step evaluations of test-day traits using all genotype data

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## I) Deregression of conventional estimated breeding values

- Pedigree-based EBV deregression by Jairath et al. (1998)
  - More accurate than EBV deregression “one animal at time” (Calus et al. 2016)
- Interbull uses deregressed national bull EBV as ‘pseudo-records’ for MACE evaluation
- Many countries use deregressed EBV (DRP) for the current 2-step genomic evaluation
- A reversibility test for validating deregressed EBV (vit, 2020)
  - Validation of deregressed bull MACE EBV on DEU scale
  - Validation of deregressed cow national EBV for all trait groups



## I) Deregression of single-step genomic breeding values

- Why deregressed single-step GEBV?
  - Deregressed bull GEBV as input 'pseudo-records' for conventional MACE evaluation
  - Countries no longer need to conduct the old conventional evaluation besides the single-step evaluation
  - Independent and most accurate response variable for GEBV validation
  - Circumvent the difficulty of DYD or YD calculation for complex model, such as random regression model
  
- Approaches for single-step deregression
  - Single-step GBLUP model (Masuda et al., 2021)
  - Single-step SNP BLUP model (Liu et al., 2021, 2022)
  - Separately for cows with phenotypic records and for bulls with daughters
  - Using all genotype data
  - Using all genomic reference information



## II) Data materials for deregressing single-step cow GEBV

April 2023 evaluation	Single-step evaluation	GEBV deregression
Frequency of	4 test-day traits	4 test-day traits
Genotyped Holstein animals	1,318,780 (1,138,039 females and 180,741 males)	
Animals with phenotype data	13,528,444	
--- phenotypic input data	263,673,267 test-day records	13,528,444 GEBV
--- record weight	Specific for each record	Effective record contribution
Genotyped or phenotyped animals	14,402,662	
Animals in pedigree	21,850,276	



## II) Special issue for deregressing single-step **bull GEBV**

- Conventional bull EBV deregression by switching phenotyped animals from cows to bulls
  - Bulls having daughters: EBV and EDC
  - Use bull pedigree (bulls and their ancestors)
- With genotyped cows available, genotyped bulls no longer represent the **full reference population**
  - Add **reference cows** (genotyped cows with own phenotypic records) to the deregression
  - Avoid double counting of cows' ERC in the mixed bull and cow reference population
- Animals with GEBV and EDC/ERC for bull GEBV deregression
  - **Bulls with daughters and reference cows: 664,548**
- Also use all genotype records of 1,318,780 animals, including young candidates



## II) Validation of the single-step deregressed GEBV (a reversibility test)

Cow GEBV deregression	Original single-step evaluation	Single-step evaluation using deregressed GEBV
Statistical model	Random regression test-day model for 3 correlated lactations	Single trait model with a general mean and GEBV
Animals with phenotypic data	13,528,444	
Number of phenotypic records	264 million test-day records	13.5 million deregressed GEBV pseudo-records
Pedigree file	Same pedigree with 22 million animals	
Genotype data	Same data with 1.4 million genotyped animals	
Validation animals with phenotype	Equal GEBV for all animals with own phenotypes?	
Validation genotyped animals	Equal GEBV for all young, genotyped candidates?	



## II) Deregressing GEBV of single-step evaluation and validation

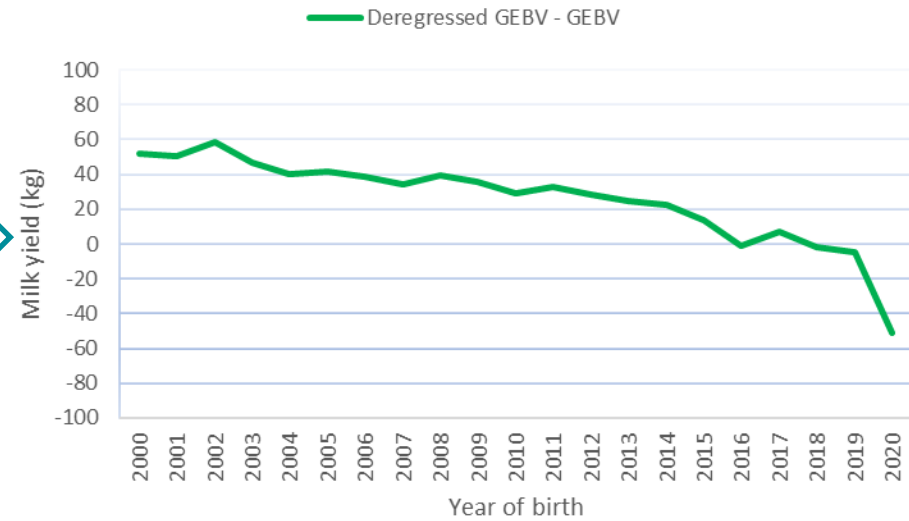
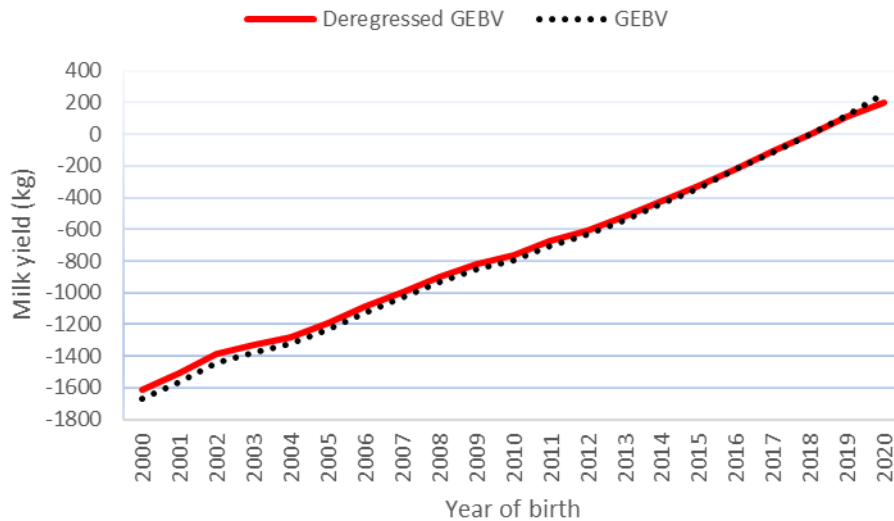
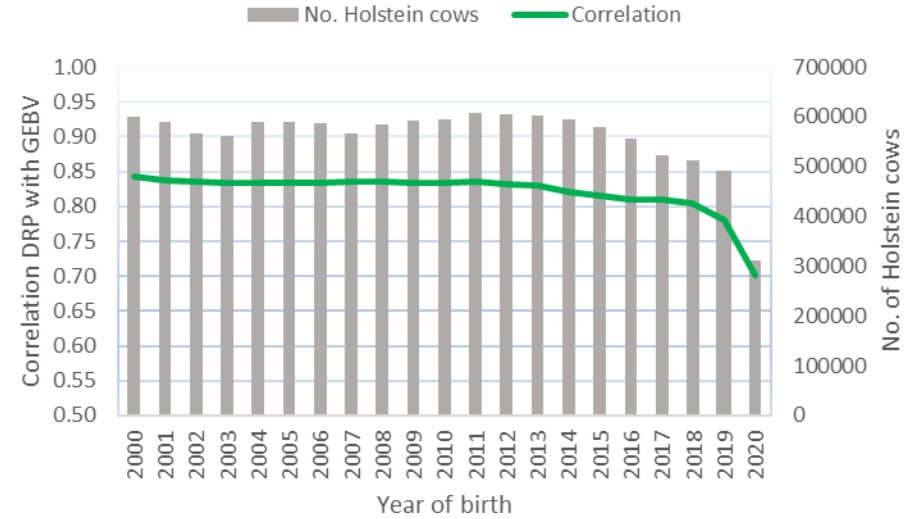
- Single-step model for test-day traits
  - A multi-lactation random regression test-day model
  - A SNP BLUP model
- Model for deregression:  $DRP = \mu + GEBV + \text{error}$  with EDC/ERC as weight
  - A single-trait model
- GEBV deregression via MiX99 (Strandén and Mäntysaari, 2010)
  - Version April 2023
  - Separate deregression processes for cows and for bulls
- Single-step evaluations for validating the deregressed GEBV
  - Same model as for GEBV deregression
- Deregression process required a little less computing time and memory usage than the original single-step evaluation



### III) Deregression results: Deregressed GEBV of cows with test-day milk yields

11.8 million Holstein cows with test-day records  
genetic standard deviation of milk yield: 640 kg

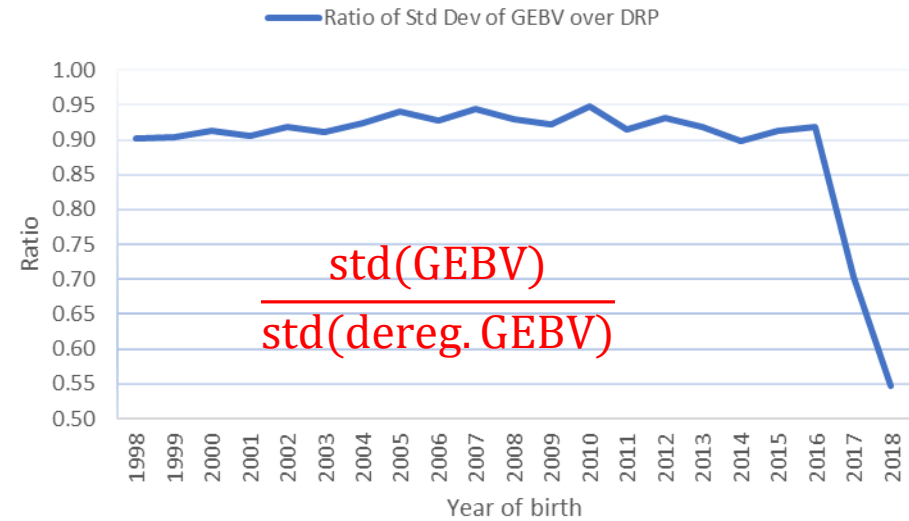
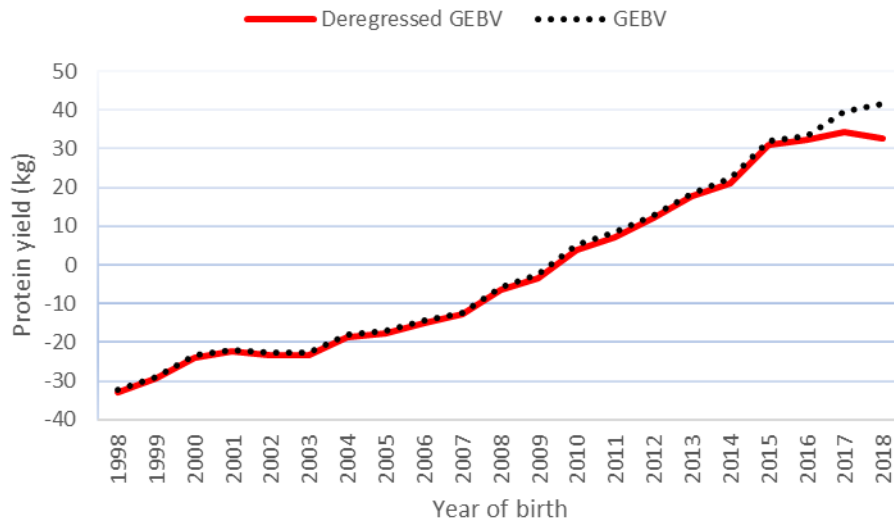
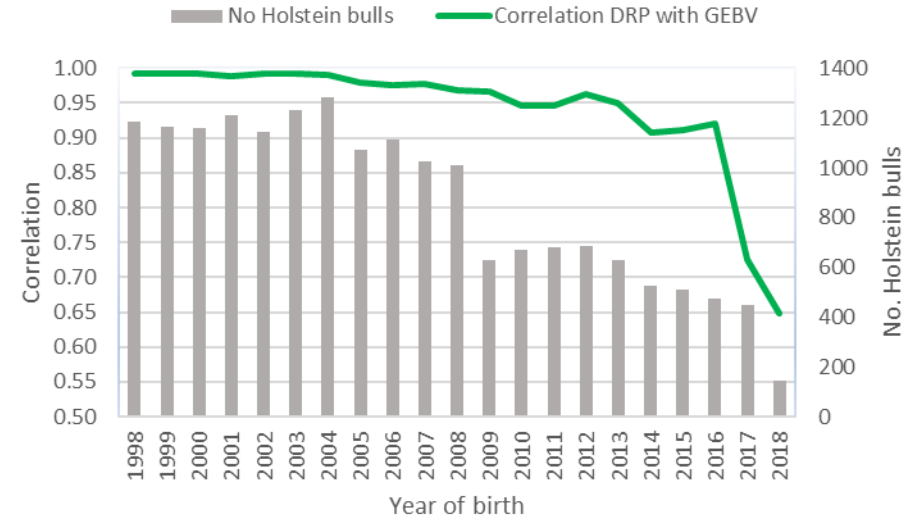
average of within-year  $\frac{\text{std}(\text{GEBV})}{\text{std}(\text{dereg. GEBV})} = 0.48$





### III) Deregression results: Deregressed GEBV of bulls with daughters

24,016 Holstein bulls with  $\geq 10$  herds in Germany  
 genetic standard deviation of **protein yield**: 17.9 kg

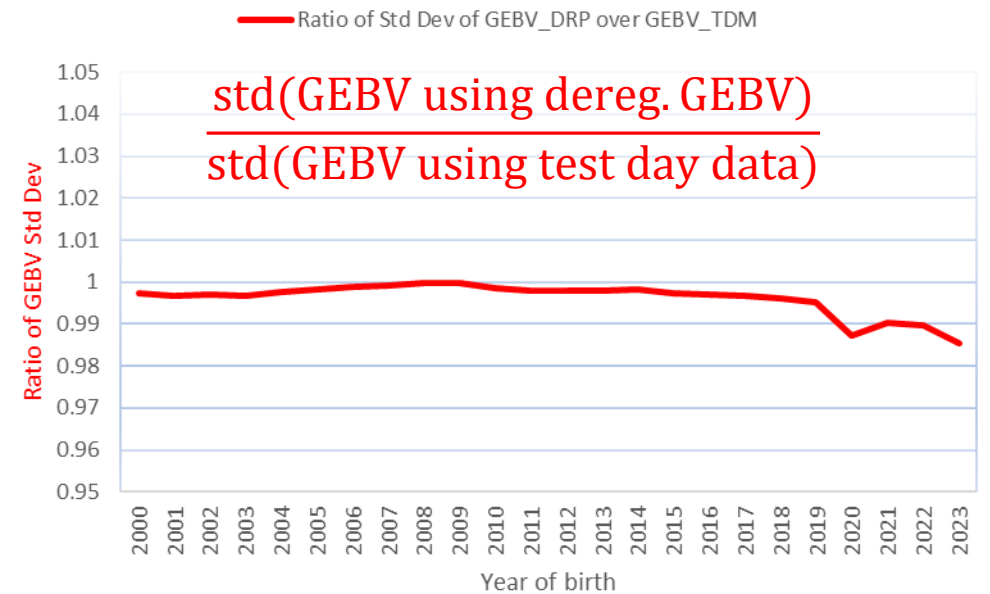
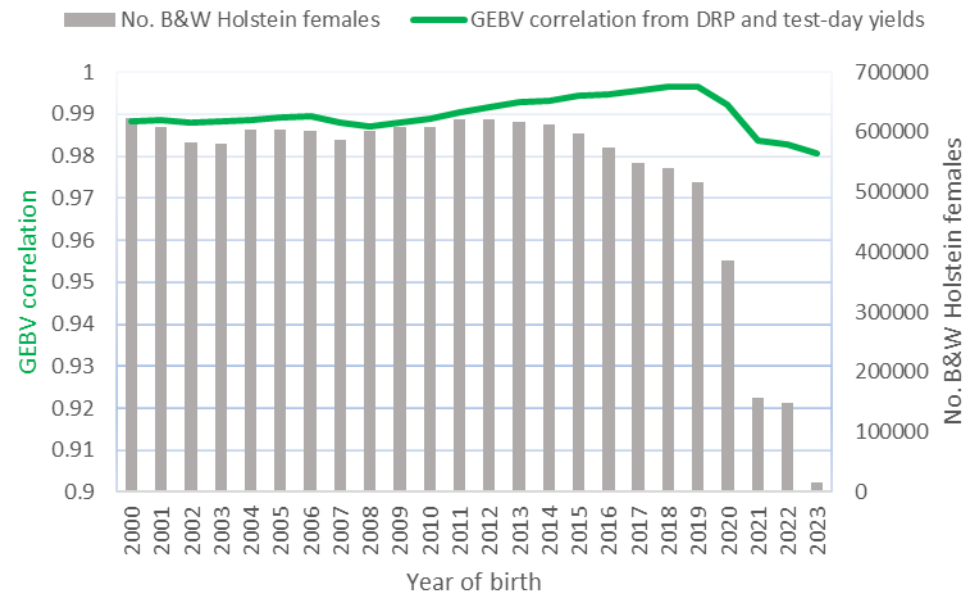


### III) Validation of cow GEBV deregression: comparison of single-step GEBV from test-day yields and from deregressed GEBV

Trait: 305-day milk yield on a combined lactation basis

12.6 million Black and White Holstein females

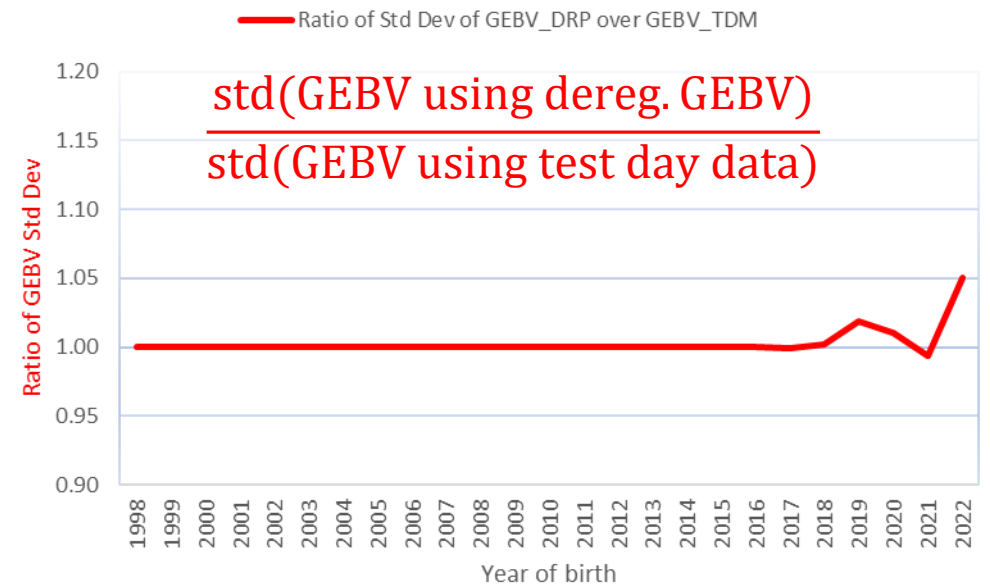
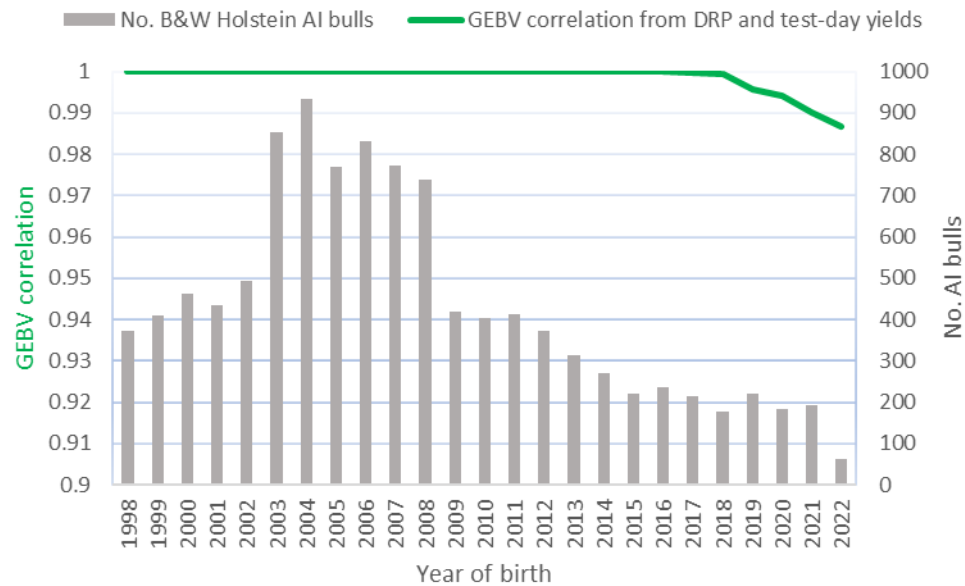
(cows with test-day records, female ancestors, genotyped candidates)



### III) Validation of bull GEBV deregression: comparison of single-step GEBV from test-day yields and from deregressed GEBV

Trait: 305-day protein yield on a combined lactation basis

10,770 Black and White German Holstein AI bulls



## IV) Summary and conclusions (1)

- GEBV deregression tested for the single-step evaluation of four test-day traits
  - For cows with test-day records as well as for bulls with daughters
  
- For bull GEBV deregression, GEBV of all reference cows must be included as input data
  
- Deregressed GEBV of the cows or bulls
  - Highly or moderately correlated with their GEBV, depending on reliabilities
  - Slightly lower trends than GEBV, especially those with lactations in progress
  - Higher variance than GEBV
  
- Deregressed GEBV versus deregressed EBV
  - Higher trend of deregressed GEBV



## IV) Summary and conclusions (2)

- Perfect validation results showed the GEBV deregression is a reversible process
  - Equal single-step GEBV using the original test-day yields and from the deregressed GEBV
  - For all cows with test-day data and for all bulls with daughters
  - For all genotyped animals, especially young candidates
  
- Deregressed GEBV desirable 'pseudo-phenotype'
  - Less auto-correlation between early (candidate) GEBV and later deregressed GEBV of validation bulls
  
- The deregression of single-step GEBV issue solved!



## Acknowledgements

Dr. Ismo Strandén and Dr. Esa Mäntysaari for their help in using MiX99 for this project



Thank you for your attention!



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