GENOTYPING OF COWS TO SPEED UP THE AVAILABILITY OF GEBVS FOR DIRECT HEALTH TRAITS – GENETIC AND ECONOMIC ASPECTS BASED ON FLECKVIEH (SIMMENTAL) AUSTRIA





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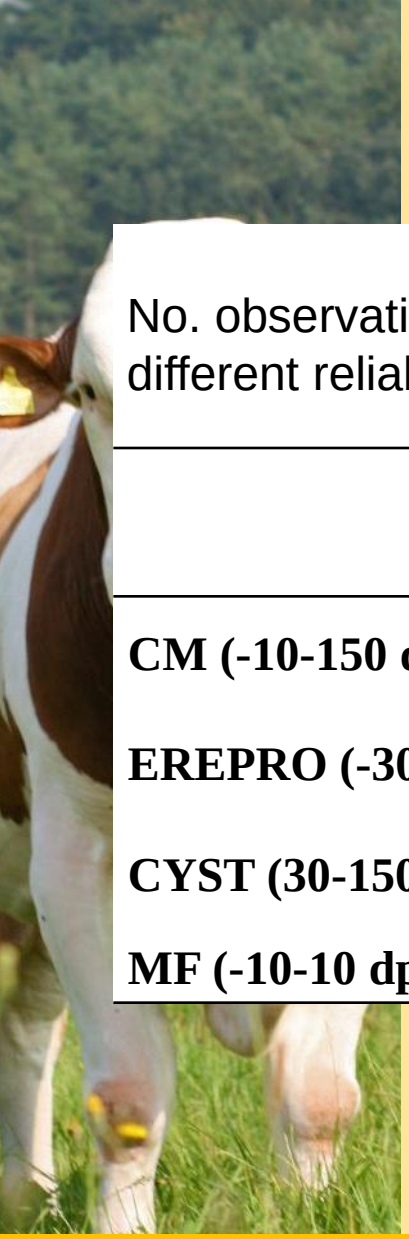
Overview

- Background
- Method and assumptions
- Results
- Conclusions

BACKGROUND

- Fleckvieh (Simmental) – main breed in Austria with 280,000 cows under performance recording.
- Genomic evaluation for all traits of the Total Merit Index (TMI)
- Joint genomic evaluation Austria and Germany (reference population (6,000 – 9,000 bulls)
- Realized reliability TMI 58% (Emmerling et al. 2012)
- But: no genomic EBVs for direct health traits available due to limited number of bulls in the reference population.



GENETIC EVALUATION – DIRECT HEALTH TRAITS

No. observations, av. incidence of disorders and no. bulls depending on different reliabilities for Fleckvieh (Egger-Danner et al. 2012)

	No. obs.	Av. inc. (%)	No. bulls (R^2>30%)	No. bulls (R^2>50%)	No. bulls (R^2>70%)
CM (-10-150 dpp)	366,853	9.8	1832	408	187
EREPRO (-30 dpp)	368,530	5.0	2094	469	214
CYST (30-150 dpp)	374,070	5.4	2978	927	342
MF (-10-10 dpp)	373,184	2.4	2816	790	307

CM clinical mastitis, EREPRO – early reproductive disorders, CYST - cystic ovaries, MF - milkfever

There is the need to undertake measures to speed up the availability of GEBVs for direct health traits.

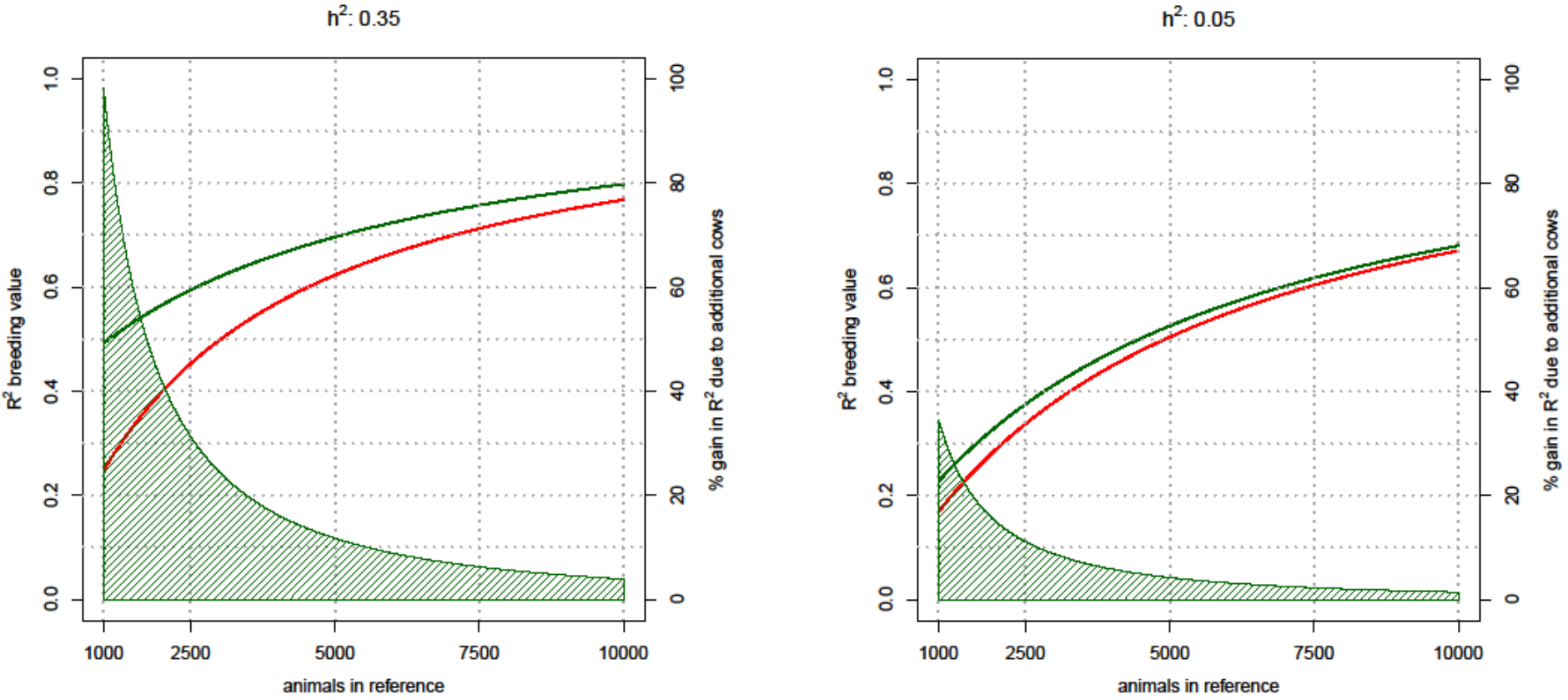
WHY GENOTYPING COWS?

- de Roos (2011): reference population of 3,000 bulls comparable with 21,000 cows (trait heritability 0.1).
- Heritablities for direct health traits often lower, therefore, **phenotypes and genotypes** of even more cows needed.
- Important to record all cows of the herds!
- Impact of genotyping cows on
  - reliability of TMI,
  - annual monetary genetic gain (AMGG),
  - discounted profit?

METHOD AND ASSUMPTIONS

- **Deterministic modelling of breeding program** (Computer program ZPLAN, Willam et al. 2008)
  - Gene flow method and selection index procedure
  - Population, biological and cost parameters
- **Total Merit Index (TMI):**
  - Direct health traits (CM, EREPRO, CYST) are used as auxiliary traits for the TMI traits fertility index and udder health index (Egger-Danner et al. 2012; Koeck et al. 2010a,b; Fuerst et al. 2010)
- **Breeding strategy: GS50**
  - GS50: 50% of the cow population and bull dams are mated with young bulls (combined pedigree and genomic information)
- **Number of cows genotyped:**
  - 5,000 / 25,000 / 50,000 cows
- **Costs of genotyping:**
  - 150 / 100 / 50 / 20 Euros

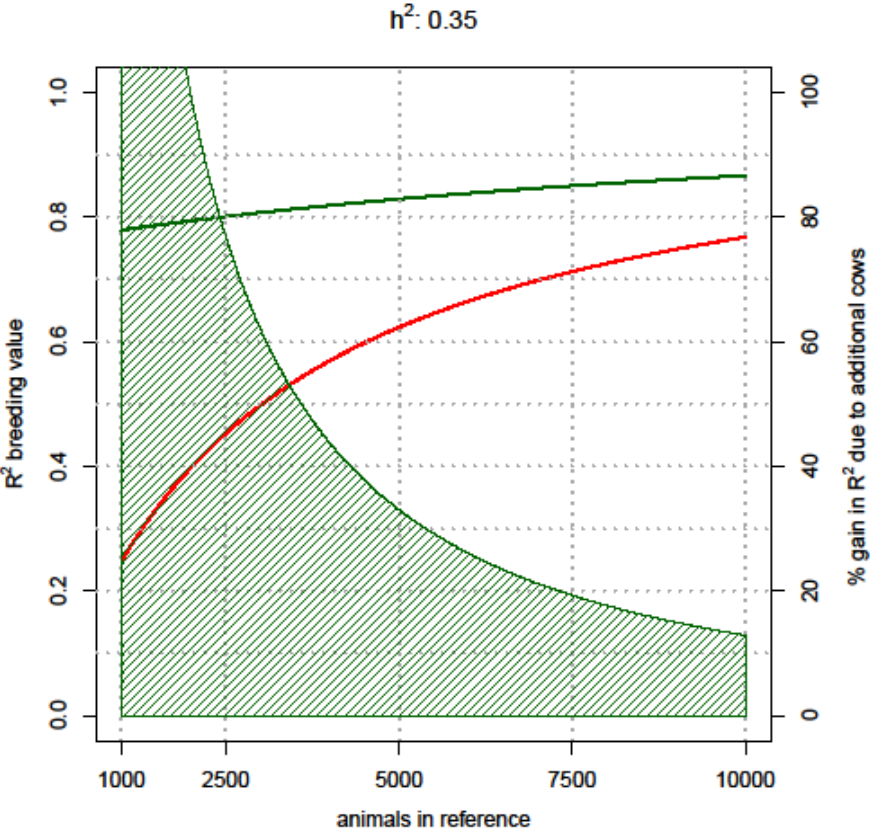
IMPACT OF GENOTYPING 5.000 COWS ADDITIONALLY TO BULLS ON RELIABILITY (R^2) FOR DIFFERENT TRAITS (h^2=0.35; h^2=0.05)

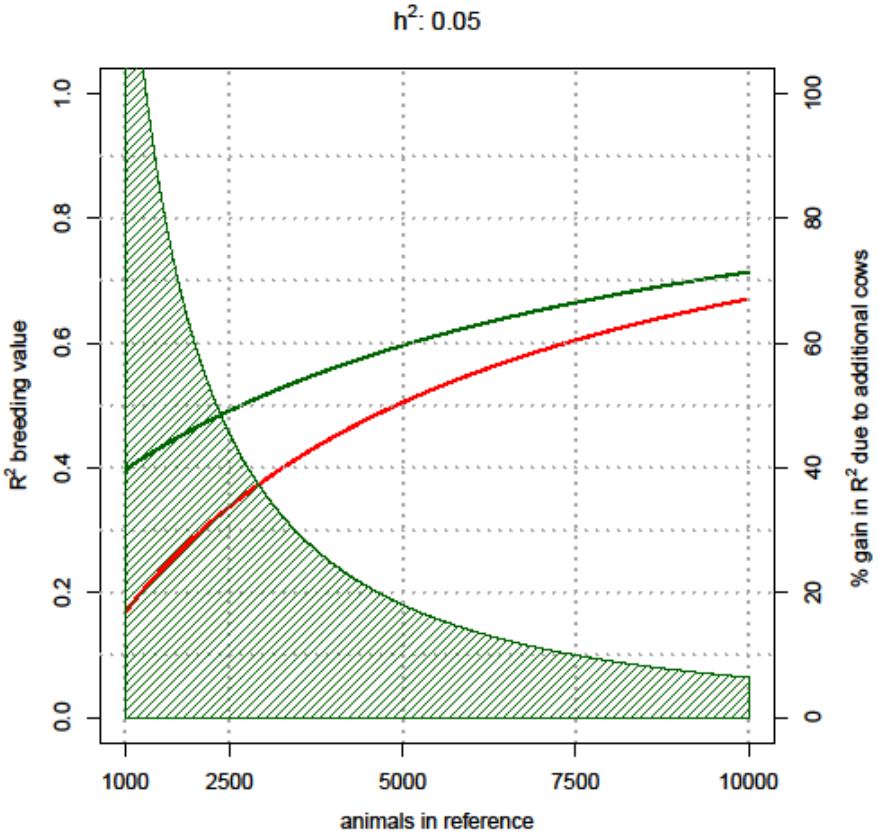


red line – only bulls / **green line** - cows addtional to bulls

(Daetwyler et al. 2010; Schwarzenbacher, 2012)

IMPACT OF GENOTYPING 25,000 COWS ADDITIONALLY TO BULLS ON RELIABILITY (R^2) FOR DIFFERENT TRAITS (h^2=0.35; h^2=0.05)

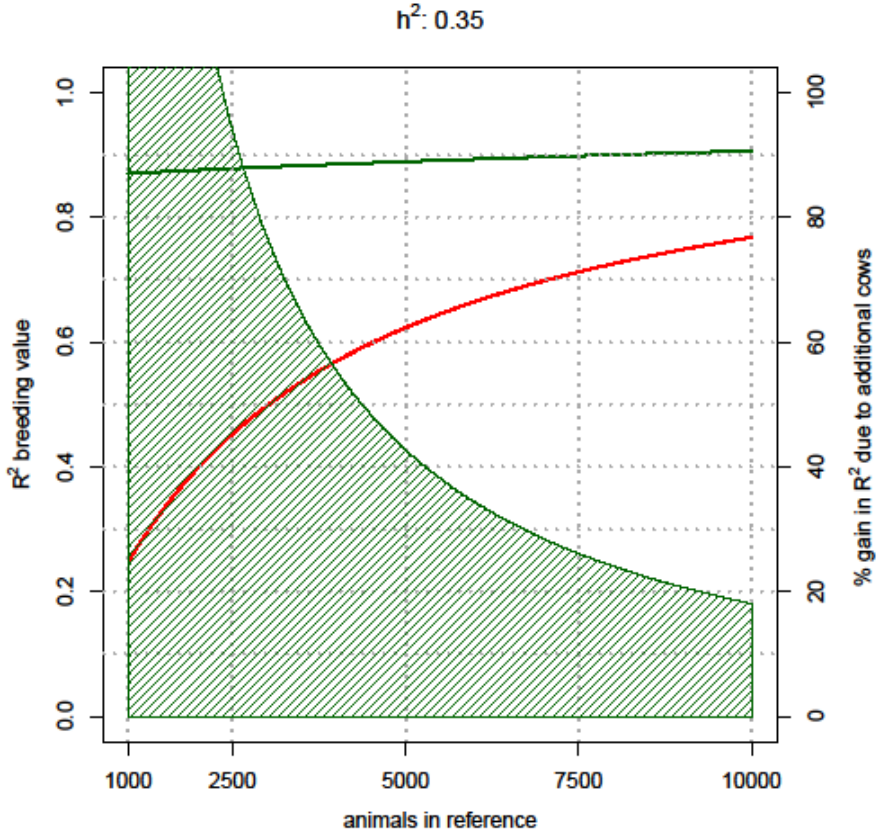


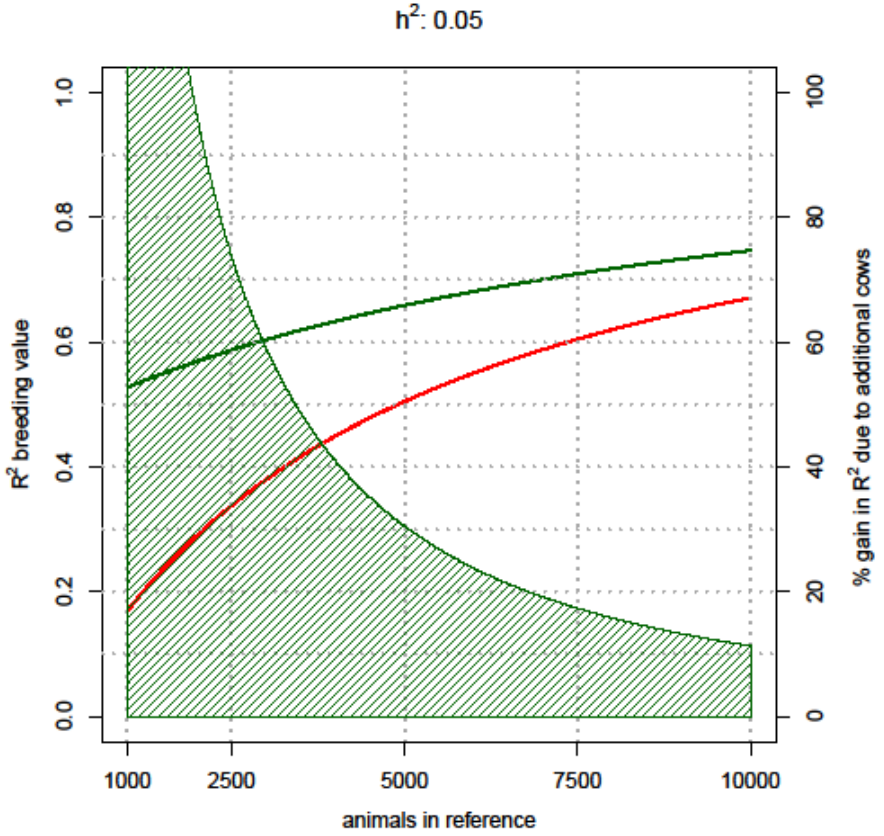


red line – only bulls / **green line** - cows addtional to bulls

(Daetwyler et al. 2010; Schwarzenbacher, 2012)

IMPACT OF GENOTYPING 50,000 COWS ADDITIONALLY TO BULLS ON RELIABILITY (R^2) FOR DIFFERENT TRAITS (h^2=0.35; h^2=0.05)





red line – only bulls / **green line** - cows addtional to bulls

(Daetwyler et al. 2010; Schwarzenbacher, 2012)

OVERVIEW:

IMPACT OF GENOTYPING COWS ADDITIONALLY TO BULLS ON RELIABILITY (R^2) FOR DIFFERENT TRAITS (h^2=0.35; h^2=0.05)

Ref. pop. bulls	5,000		25,000		50,000	
	h^2 = 0.35	h^2 = 0.05	h^2 = 0.35	h^2 = 0.05	h^2 = 0.35	h^2 = 0.05
10,000	0.03	0.01	0.10	0.04	0.14	0.08
7,500	0.04	0.01	0.14	0.06	0.19	0.10
5,000	0.07	0.02	0.21	0.09	0.27	0.15
2,500	0.14	0.04	0.35	0.15	0.43	0.25
1,000	0.24	0.06	0.53	0.23	0.62	0.36

ZPLAN – ASSUMPTIONS GENOTYPING COWS

Initial situation:

- Reliability for TMI not just single traits
- Dairy and beef traits much higher impact on realization of genetic gain (≈85%)
- Currently different reference populations of bulls for trait groups
  - dairy traits ≈ 6,000
  - functional traits ≈ 4,000 - 9,000
  - direct health traits ≈ 1,000

Assumptions genotyping cows:

Gain in reliability from genotyping cows is solely based on model assumptions (Daetwyler et al. 2010)!

- No cows → R^2=0.58
- + 5,000 cows → +0.05
- + 25,000 cows → +0.15
- + 50,000 cows → +0.25

ZPLAN – Criteria for Evaluation

- **Annual monetary genetic gain (AMGG):**
  Average monetary superiority per year of the progeny of the selected animals of one selection round in the breeding unit.
- **Discounted return (R):**
  Discounted monetary value per cow based on the genetic superiority and expresssed by improved animals in the breeding and production unit (i.e. entire population) over the given investment period.
- **Discounted profit (P):**
  Discounted return minus discounted breeding costs per cow.

ZPLAN - RESULTS

Annual monetary genetic gain (AMGG) in € and %:

Reliability	AMGG(€)	AMGG%
No cows genotyped (R^2=0.58)	28.02	100%
+5,000 cows (+0.05)	28.44	+1,50%
+25,000 cows (+0.15)	29.16	+4.07%
+50,000 cows (+0.25)	29.85	+6.53%

Discounted profit per cow (%):

Reliability	Costs of genotyping per cow (€)			
	150	100	50	20
No cows genotyped (R^2=0.58)	100%			
+5,000 cows (+0.05)	+1.36%	+1.79%	+2.15%	+2.44%
+25,000 cows (+0.15)	+1.29%	+3.08%	+4.94%	+6.02%
+50,000 cows (+0.25)	-0.01%	+3.22%	+7.09%	+9.24%

CONCLUSIONS

- Genotyping cows increases the reliability of high heritable traits considerably more than low heritable traits.
- The impact of genotyping cows on reliability is more effective in case of smaller reference populations of bulls.
- Therefore, more reliable GEBVs for novel traits like direct health traits are available sooner.
- But, for these novel traits (ususally low heritable) many reliable phenotypes and genotypes are needed.
- Genotyping cows impacts annual monetary genetic gain just moderately if no changes in selection intensity and generation intervall are implemented.
- If genotyping of cows has to be paid by the breeding organisation only it hardly pays off as long as genotyping is expensive.
- Joint approaches across countries are needed!

ACKNOWLEDGEMENT

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Thank you for your attention!