IMPACT OF BREEDING STATEGIES USING GENOMIC INFORMATION ON FITNESS AND HEALTH





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BACKGROUND

- Fleckvieh AUSTRIA: 280,000 herdbook cows (25,567 kg lifetime milk yield; longevity: 3.6 yr; calving interval: 398 d; somatic cell count: 189.000/ml.
- Fleckvieh AUSTRIA: high genetic gain for kg milk during the last 10 years (92 kg milk/yr); 3.03 protein kg/yr.
- Genetic gains of functional traits not satisfactory.
- Survey among breeders: strong demand to improve fertility, udder health, feet and legs and only moderate genetic gain for dairy traits.
- **New tools available**:
  - phenotypic information for direct health traits
  - genomic selection.

What can be done?

QUESTIONS

- Impact of inclusion of direct health traits in the Total Merit Index (TMI)?
- Impact of application of genomic selection on monetary and natural genetic gain for dairy, fitness and direct health traits?
- Which measures need to be undertaken to increase the genetic gain for fitness and health?

METHOD

- **ZPLAN: Deterministic modelling of breeding programme**
  - Gene flow and selection index procedures
  - Population and cost parameters, biological coefficients
- **Variation of Total Merit Index (TMI):**
  - TMI without direct health traits (DHT)
  - TMI+DHT: TMI with direct health traits according economic weights and genetic parameter (fertility index; udder health index) (Koeck et al. 2010a,b; Fuerst et al. 2010)
  - TMI+DHT50: TMI+DHT with increased economic weights for the fertiltiy index and udder health index by 50%
- **Alternative breeding plans:**
  - CPT: Conventional progeny test (25% test bulls)
  - GS50: Genomic selection (50% young bulls mated with bull dams and cow population)
  - GS100: only young bulls, no progeny tested bulls used.

ASSUMPTIONS TMI

- **TMI:** without the inclusion of direct health traits
  - **Fertility index**: NR 56 (heifer and cow), interval between first and last insemination (heifer and cow)
  - udder: somatic cell count.
- **TMI+DHT**: TMI with direct health traits (DHT)
  - **Fertility index**:

    NR56 (heifer and cow), interval between first and last insemination (heifer and cow),

    NEW: early reproduction disorders (EREPRO) and cystic ovaries (CYST).

    Economic weight for EREPRO and CYST derived and included.
  - **Udder Health Index**:

    Somatic cell count (SCC), **NEW**: mastitis, type traits: udder score, udder depth, suspensory ligament, fore udder attachment, teat placement.

    Costs of mastitits already included in deviation of economic weight of SCC, therefor no additional weight considered!
- **TMI+DHT50:** weights of fertility and udder health index increased by 50%

FLECKVIEH TMI- PRESENT WEIGHT

		w per unit	s_A	w per s_A	Relative (%)	
Dairy	**Fat kg**	0.45	21,9	9.86	4.4	**37.8**
	Protein kg	4.50	16,4	73.80	33.4	
Beef	**Net daily gain**	1.34	12	16.08	7.3	**16.5**
	Dressing %	0.85	12	10.20	4.6	
	Trading score	0.85	12	10.20	4.6	
Fitness	**Longevity**	2.47	12	29.64	13.4	**43.7**
	Persistency	0.36	12	4.32	2.0	
	Fertility I	1.25	12	15.00	**6.8**	
	Calving ease	0.68	12	8.16	3.7	
	Still birth	1.49	12	17.88	8.1	
	SCC	1.78	12	21.36	**9.7**	
	Milkability	0.36	12	4.32	2.0	**2.0**

Presently no direct health traits are included within the Total Merit Index in Austria and Germany (DEA).

FLECKVIEH TMI+DHT (TMI)

		w per unit	s_A	w per s_A	Relative (%)	
Dairy	**Fat kg**	0.45	21.9	9.86	**4.2**(4.4)	**35.7**(37.9)
	Protein kg	4.50	16.4	73.80	**31.5**(33.4)	
Beef	**Net daily gain**	1.34	12	16.08	**6.9**(7.3)	**15.6**(16.5)
	Dressing %	0.85	12	10.20	**4.4**(4.6)	
	Trading score	0,85	12	10.20	**4.4**(4.6)	
Fitness	**Longevity**	2.47	12	29.64	**12.6**(13.4)	**46.9**(43.7)
	Persistency	0,36	12	4.32	**1.8**(2.0)	
	Fertility I	1.25	12	**28.43**(15.00)	**12.1**(6.8)	
	Calving ease	0.68	12	8.16	**3.**4(3.7)	
	Still birth	1.49	12	17.88	**7.6** (8.1)	
	Udder Health I	1.78	12	**21.36** (21.36)	**9.1**(9.7)	
	Milkability	0.36	12	4.32	**1.8**(2.0)	**1.8** (2.0)

Direct health traits are included according their economic weights and the genetic parameters within the fertility and udder health index.

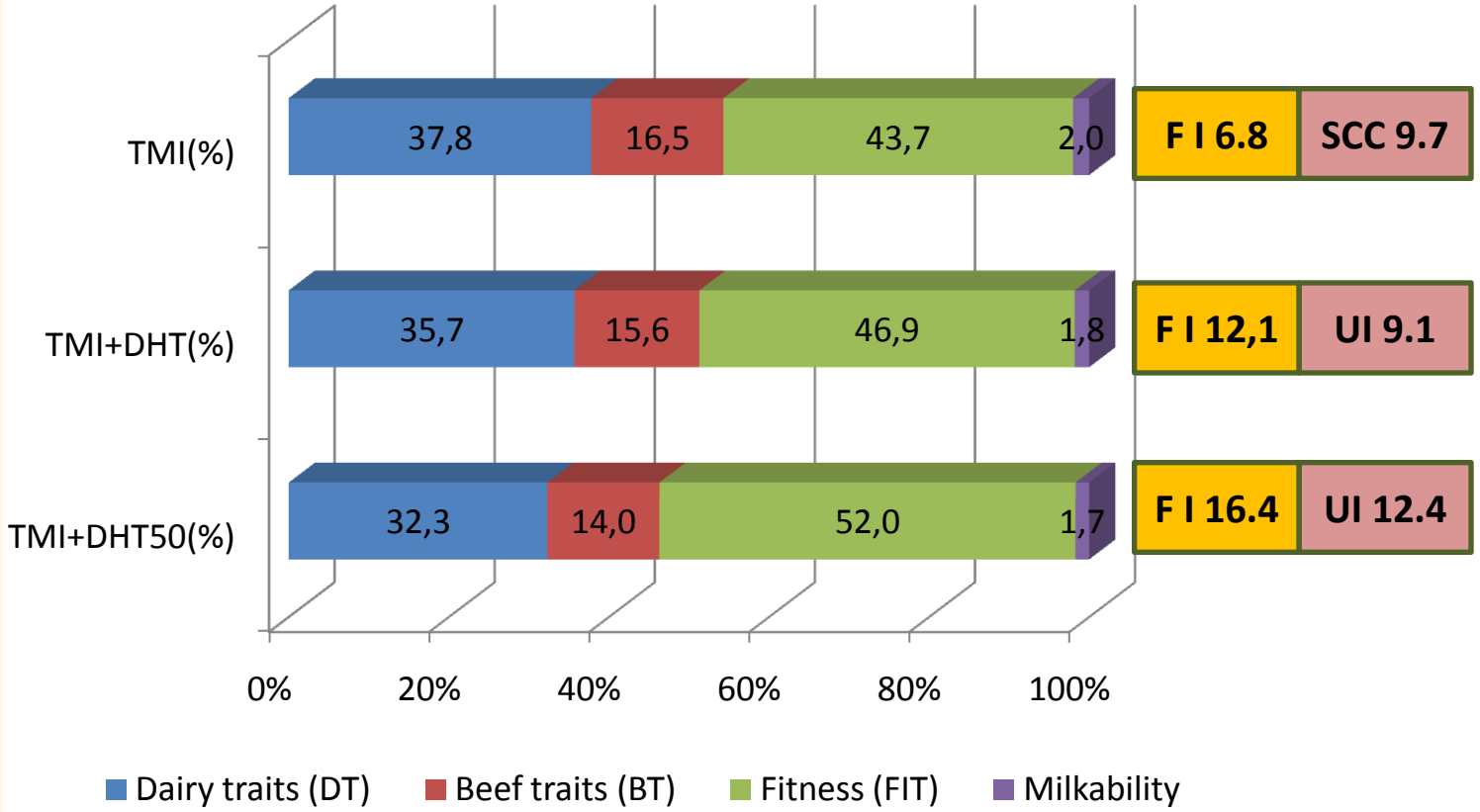
FLECKVIEH TMI+DHT50 (TMI)

		w per unit	s_A	w per s_A	Relative (%)	
Dairy	**Fat kg**	0.45	21.9	9.86	**3.8**(4.4)	**32.3**(37.9)
	Protein kg	4.50	16.4	73.80	**28.5**(33.4)	
Beef	**Net daily gain**	1.34	12	16.08	**6.2**(7.3)	**14.0**(16.5)
	Dressing %	0.85	12	10.20	**3.9**(4.6)	
	Trading score	0,85	12	10.20	**3.9**(4.6)	
Fitness	**Longevity**	2.47	12	29.64	**11,4**(13.4)	**52.0**(43.7)
	Persistency	0,36	12	4.32	**1.7**(2.0)	
	Fertility I	1.25	12	**42.64**(15.00)	**16.4**(6.8)	
	Calving ease	0.68	12	8.16	**3.**2(3.7)	
	Still birth	1.49	12	17.88	**7.0** (8.1)	
	Udder Health I	1.78	12	**32.04**(21.36)	**12.4**(9.7)	
	Milkability	0.36	12	4.32	**1.7**(2.0)	**1.7** (2.0)

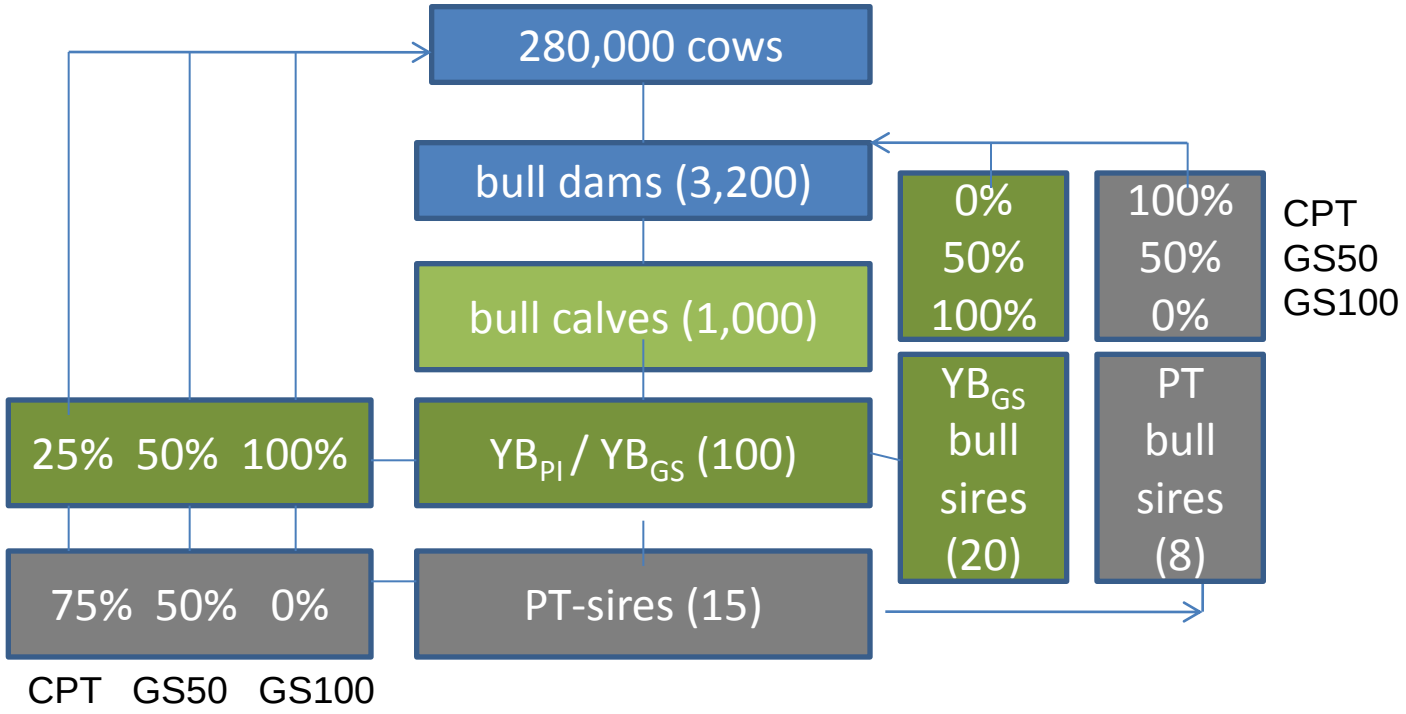
Economic weight of fertility and udder health index increased by 50%.
Monetary and natural genetic gain calculated based on real economic weights.

Parameter

Summary of relative economic weights



ASSUMPTIONS – BREEDING STRUCTURE (CPT, GS50, GS100)



Only percentage of insemination of cows and bull dams was changed. No change in selection intensities considered!

PARAMETER

RELIABILITY (R^2) OF EBVS

Definitions:

YB_{PI} - Young bull with pedigee index TMI (PI)

YB_{GS} - Young bull with genomic TMI (GS)

PT-bull - Progeny tested bull with TMI

	YB_{PI}	YB_{GS}	PT-bull
CPT TMI	0,33		0,85
CPT TMI+DHT50	0,31		0,79
GS50 TMI		0,59	0,88
GS50 TMI+DHT50		0,57	0,83

CRITERIA FOR EVALUATION OF ALTERNATIVE BREEDING PROGRAMMES

- **Annual monetary genetic gain (AMGG%):**
  Monetary superiority (per year) of progeny of the selected animals of one selection round in the breeding unit in % related to TMI of CPT.

- **Annual genetic gain (AGG):**
  Annual genetic gain (genetic S.D. units x 100).

RESULTS

- **Annual monetary genetic gain (AMGG%) for TMI:**

	GI (yr)	TMI	TMI+DHT	TMI+DHT50
CPT	5.54	**100**	101	99
GS50	4.69	115	116	114
GS100	3.57	130	132	129

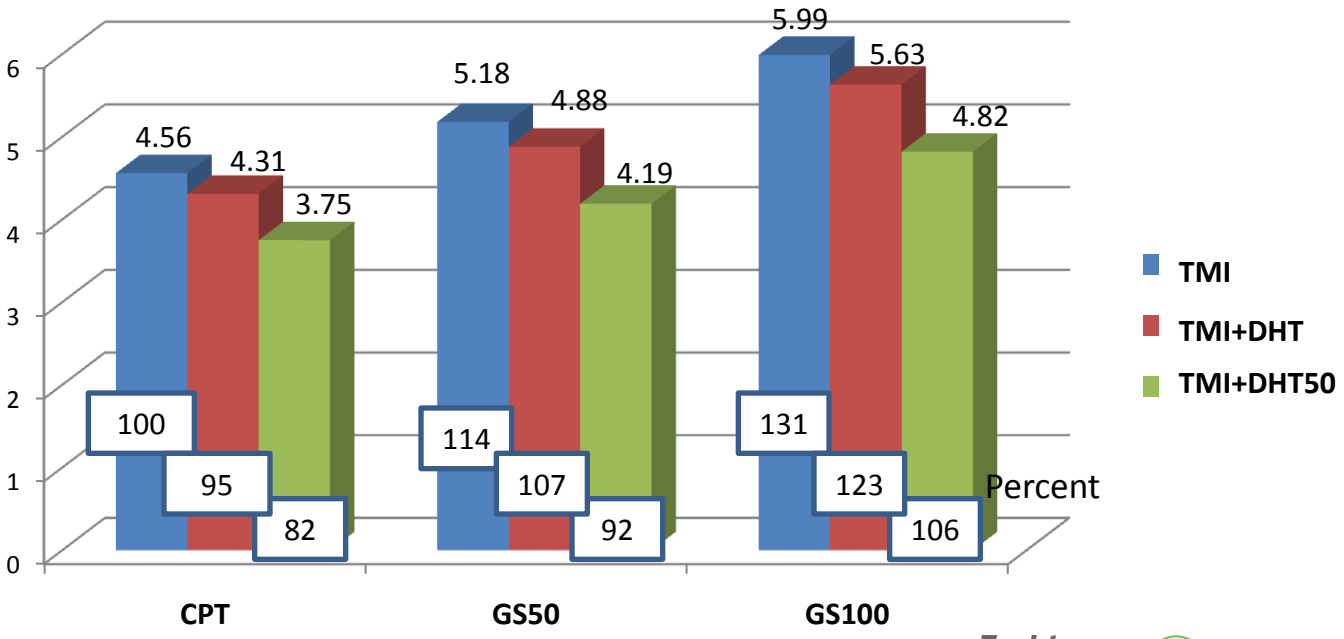
- **AMGG% for milk and fitness (health) complex:**

	TMI		TMI-DHT		TMI-DHT50	
	DT	FIT	DT	FIT	DT	FIT
CPT	81	7	76	11	69	20
GS50	79	9	74	14	66	23
GS100	80	8	75	15	67	23

DT: Dairy traits; FIT: Fitness traits

RESULTS – PROTEIN KG

Effect of different breeding structures (CPT, GS50,GS100) and different TMIs (TMI, TMI+DHT, TMI+DHT50) on annual genetic gain of protein kg (genetic S.D. units x 100)



RESULTS

FERTILITY INDEX AND SCC/UDDER HEALTH INDEX

Effect
on annual genetic gain of fertility index and SCC/udder health index (genetic S.D. units x 100) (pt. EBV)

	TMI		TMI-DHT		TMI-DHT50	
	Fertility Index	SCC	Fertility Index	Udder H I	Fertility Index	Udder H I
CPT	-0.15	-0.08	0.22	0.07	0.61	0.50
GS50	-0.11	-0.09	0.37	0.10	0.85	0.61
GS100	-0.15	-0.19	0.42	0.08	0.99	0.68

Summary: positive trend is enforced by GS, if trend for fitness and health is negative, GS does not change a negative trend towards a positive direction.

CONCLUSIONS

- **Genetic gain for fitness and health**:
  - **GS50**: higher number of progeny result in higher reliabilities of breeding values for progeny tested bulls – positive development of genetic gain for fitness and health traits per year
  - **GS100**: partly still improvement of natural genetic gain per year due to shorter generation intervall (genetic gain per generation is lower!)

Precondition to improve genetic gain for fitness and health is an appropriate weight within the TMI.

The direction to go has to be defined by the TMI, genomic selection measures within the breeding programme define the speed to go!

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Thank you for your attention!