Bern University of Applied Sciences

Genetic analyses of linear traits in Swiss Warmblood – challenges in research and routine

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Overview

- Introduction
- Linear description:
  - Number of observations per year
  - Effects of expert and place*date
  - Utilization of scale
- Variance component estimation
  - Field test and promotion
  - Linear description

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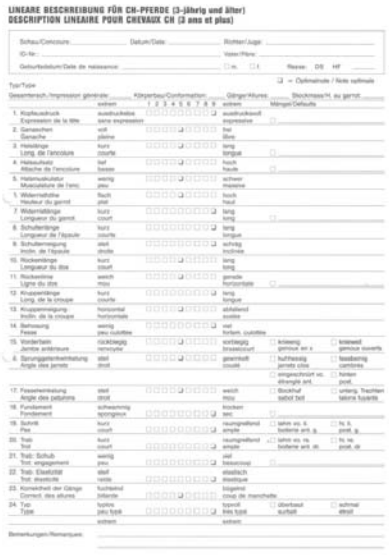
[Photo: Katja Stuppia]

Introduction

- Until 1990 conformation was judged by using a pointsystem with three degrees (satisfactory, good, very good) [Wilkens & Poncet 1991].
- In 1991 linear description was introduced.
- Linear description: description of biologically possible forms.
- Nowadays the linear description contains 28 conformation traits: 1 measured, 3 judged, 24 linear described
- At the age of 3 horses are linearly described.

Introduction


LINEARE BESCHREIBUNG FÜR CH-PFERDE (3-jährig und älter)
DESCRIPTION LINEAIRE POUR CHEVAUX CH (3 ans et plus)

height at withers	measured
breed type	judged
general conformation	judged
gaits	judged
expression of the head	described with notes from 1 to 9
ventral border of mandible	described with notes from 1 to 9
length of neck	described with notes from 1 to 9
base of neck	described with notes from 1 to 9
neck muscle	described with notes from 1 to 9
wither height	described with notes from 1 to 9
length of wither	described with notes from 1 to 9
length of shoulder	described with notes from 1 to 9
angle of shoulder	described with notes from 1 to 9
length of back	described with notes from 1 to 9
line of back	described with notes from 1 to 9
length of croup	described with notes from 1 to 9
angle of croup	described with notes from 1 to 9
gaskin	described with notes from 1 to 9
fore-leg	described with notes from 1 to 9
hock angle	described with notes from 1 to 9
fetlock joint angle	described with notes from 1 to 9
conformation of legs	described with notes from 1 to 9
walking length	described with notes from 1 to 9
trotting length	described with notes from 1 to 9
dynamics of trot	described with notes from 1 to 9
elasticity of trot	described with notes from 1 to 9
correctness of gaits	described with notes from 1 to 9
type	described with notes from 1 to 9

Introduction

- Since 2004, the Swiss Sport Horse Breeding Association (ZVCH) runs a breeding program based on estimated breeding values.
- A multi-trait animal model is applied for the breeding value estimation of linear description:

$$y_{ijkl} = place*data_i + expert_j + sex_k + b_1*age_l + b_2*age_l^2 + animal_l + rest_{ijkl}$$

with:

y_{ijkl}:	Judging of conformation / measuring of height at withers / linear description, tot. 28 traits
$place*date_i$:	Effect of place*date (fix)
$expert_j$:	Effect of expert j(fix)
sex_k:	Effect of sex (fix)
b_1:	Regression coefficient of age linear
age_l:	Age of horse l at linear description
b_2:	Regression coefficient of age quadratic
$animal_l$:	Effect of horse l (genetic effect = breeding value) (random)
$rest_{ijkl}$:	Effect of rest (random)

Linear description

Number of observations per year

Year	Number of horses with linear description	Number of events (place*date)	Number of experts (combinations)
2009	413	14	10
2010	365	14	11
2011	461	13	10
2012	406	12	9
2013	366	15	9
2014	335	12	8
2015	314	12	8

[Photo: Katja Stuppia]

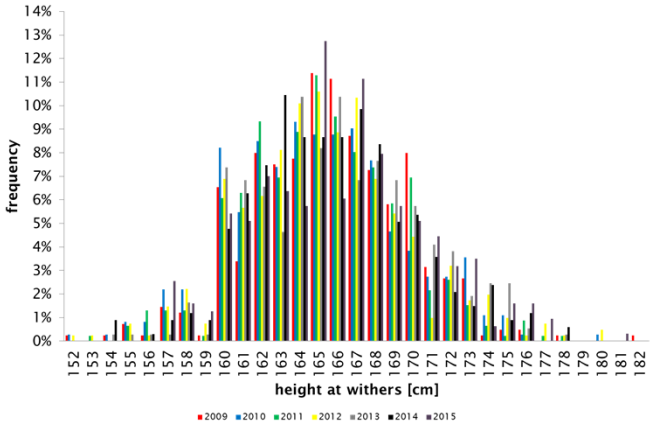
Linear description

Effects of expert and place*date

- Statististical analyses showed that expert and place*date have a significant effect. ➔ That's why they are considered for the estimation of breeding values.
- But it is difficult to quantify these effects, because of so many different categories (e.g. combinations of experts). ➔ We cannot draw a conclusion.
- The effects of the single experts would be meaningful for the regular training of experts.

Linear description

Utilization of scale – height at withers (measured)



[Burren 2017, Bangerter 2014]

Linear description

Utilization of scale – 3 judged traits

- For breed type, general conformation and gaits mainly the notes 6, 7 and 8 are given. Only 3% of horses have a note of 9 or ≤ 5.

Linear description

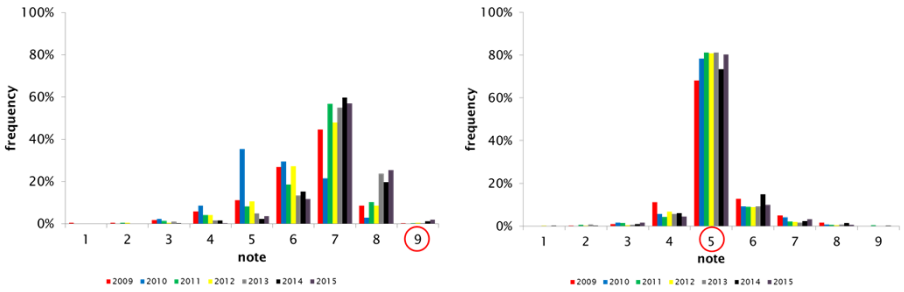
Utilization of scale – 24 described traits

Trait	Breeding goal	2015		2014		2013		2012		2011		2010		2009	
Expression of the head	9	7	54%	7	44%	7	55%	7	52%	7	44%	7	39%	7	37%
Ventral border of mandible	5	5	63%	5	71%	5	65%	5	63%	5	65%	5	70%	5	50%
Length of neck	5	5	82%	5	78%	5	78%	5	86%	5	81%	5	78%	5	55%
Base of neck	5	5	77%	5	75%	5	70%	5	80%	5	74%	5	67%	5	60%
Neck muscle	5	5	76%	5	71%	5	70%	5	68%	5	71%	5	67%	5	51%
Wither height	5	5	70%	5	73%	5	69%	5	70%	5	65%	5	55%	5	48%
Length of wither	9	7	39%	7	38%	7	33%	7	28%	6	33%	6	30%	6	34%
Length of shoulder	9	7	60%	7	57%	7	45%	7	58%	7	48%	6	41%	6	44%
Angle of shoulder	9	7	43%	7	39%	7	35%	7	33%	7	33%	5	34%	5	32%
Length of back	5	5	85%	5	75%	5	64%	5	81%	5	71%	5	74%	5	44%
Line of back	5	5	54%	5	57%	5	55%	5	66%	5	54%	5	52%	5	49%
Length of croup	9	7	61%	7	56%	7	46%	7	53%	7	43%	6	38%	6	39%
Angle of croup	5	5	48%	5	53%	5	49%	5	56%	5	53%	5	53%	5	46%
Gaskin	9	7	51%	7	48%	7	30%	7	40%	6	47%	6	45%	6	47%
Fore-leg	5	5	94%	5	90%	5	88%	5	93%	5	89%	5	95%	5	82%
Hoch angle	5	5	73%	5	66%	5	70%	5	66%	5	58%	5	50%	5	45%
Fetlock joint angle	5	5	84%	5	81%	5	82%	5	86%	5	81%	5	83%	5	72%
Conformation of legs	9	7	57%	7	60%	7	55%	7	48%	7	57%	5	35%	7	45%
Walking length	9	7	58%	7	55%	7	59%	7	53%	7	50%	7	51%	7	51%
Trotting length	9	7	48%	7	48%	7	57%	7	51%	7	51%	7	51%	7	45%
Dynamics of trot	9	7	45%	7	45%	7	53%	7	44%	7	42%	7	42%	7	38%
Elasticity of trot	9	7	46%	7	52%	7	51%	7	43%	7	47%	7	39%	7	42%
Correctness of gaits	5	5	80%	5	73%	5	81%	5	81%	5	81%	5	78%	5	68%
Type	9	8	49%	7	45%	8	48%	7	51%	7	45%	7	52%	7	50%

[Burren 2017, Bangerter 2014]

Linear description

Utilization of scale – conformation of legs and correctness of gaits



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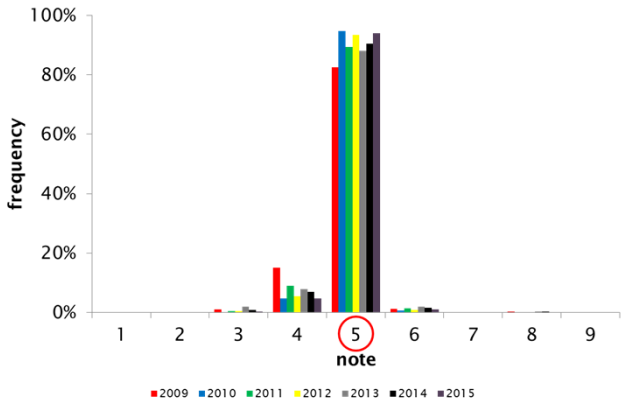
[Burren 2017, Bangerter 2014]

Linear description

Utilization of scale – fore-leg



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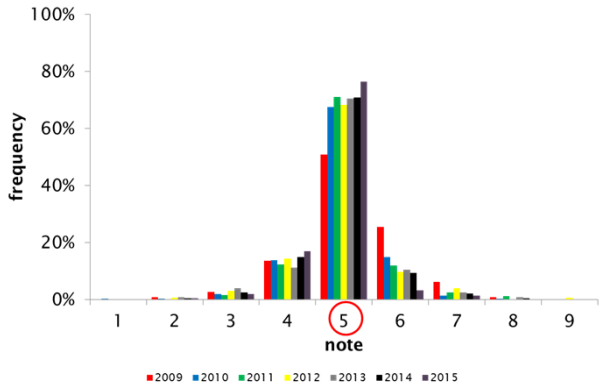
[Burren 2017, Bangerter 2014]

Linear description

Utilization of scale – neck muscle



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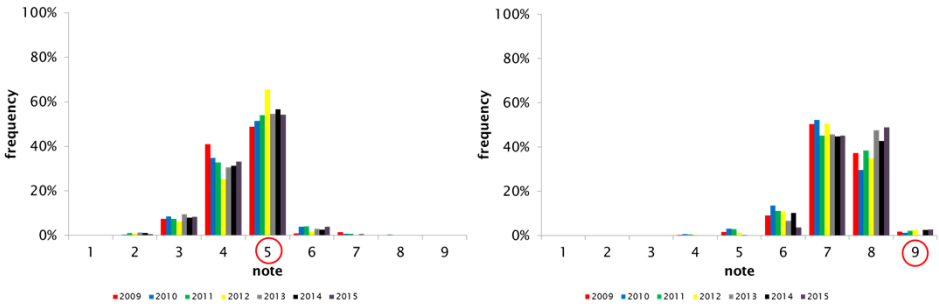
[Burren 2017, Bangerter 2014]

Linear description

Utilization of scale – line of back and type



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[Burren 2017, Bangerter 2014]

Linear description

Utilization of scale - conclusions

- Why is the scale not fully utilized?
  - Extreme animals do not exist in the population?
  - Experts tend to prevent extreme notes?
- Results serve as a basis for discussion with experts, further development of linear description and for the training/scaling of experts.
- An objective description of horses and the full utilization of scale are important for a reliable estimation of breeding values [Wilkens & Poncet 1991].

Variance component estimation

2004

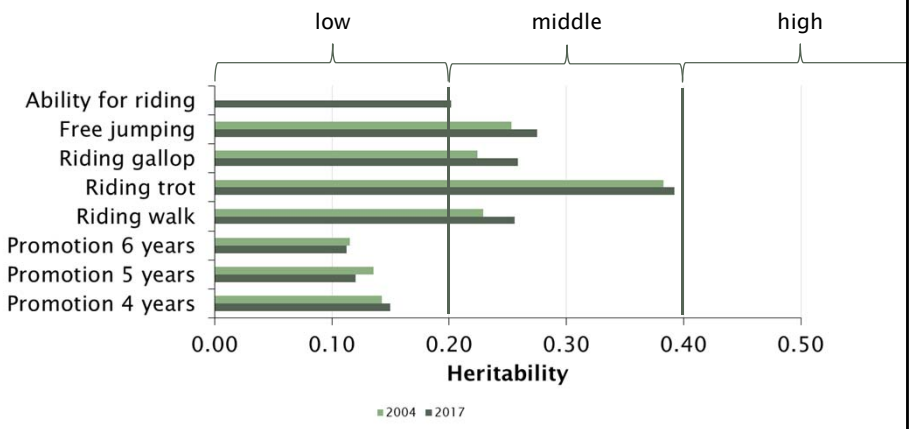
- Linear description data from 1994-2004: 6,837 horses
- Field test and promotion data from 1991-2004: 8,738 horses

2017

- Linear description data from 1994-2015: 11,408 horses
- Field test and promotion data from 1991-2015: 13,431 horses

Variance component estimation

Heritability for field test and promotion



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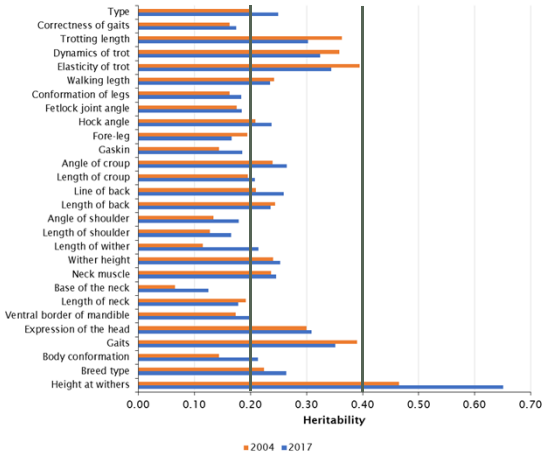
Variance component estimation

Heritability for linear description



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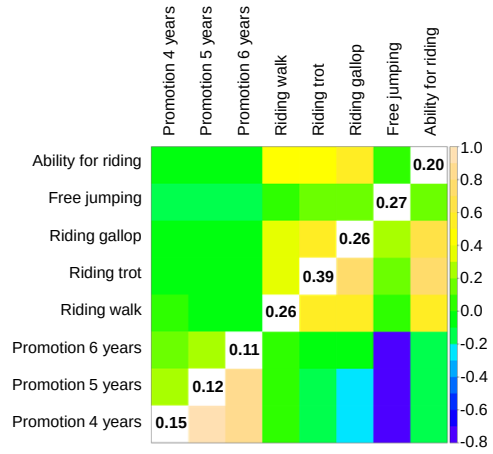
[Burren 2017]

Variance component estimation

Correlations for field test and promotion

above diagonal: phenotypic correlations
below diagonal: genetic correlations

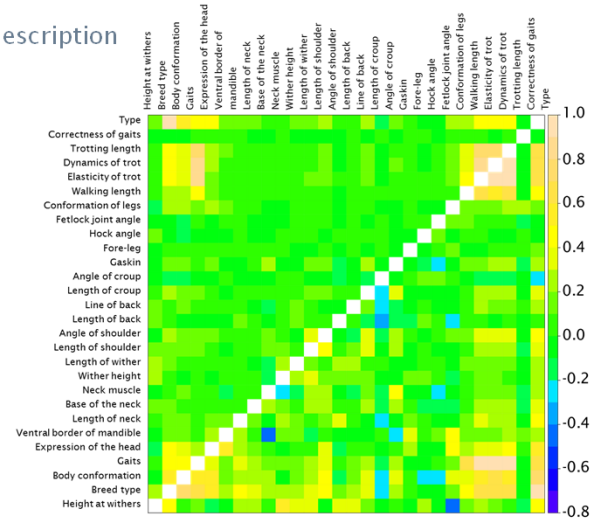


[Burren 2017]

Variance component estimation

Correlations for linear description

above diagonal: phenotypic correlations
below diagonal: genetic correlations



[Burren 2017]

Variance component estimation

Conclusions

- From time to time it is appropriate to renew the estimation of population parameters.
  - Reliability of estimated breeding values?
  - Ranking of animals?

Thank you for your attention!