vit IT-Solutions for Animal Production

WBFSH

Virtual WBFSH General Assembly
on October 13th, 2021

EAAP Horse Commission Report

- report from EAAP 2021, activities and plans

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EAAP European Federation of Animal Science

The Horse Study Commission

Outline

- EAAP Horse Commission
- EAAP annual meeting 2021
  - → news from research and beyond
  - major topics at the conference
  - hot topics for sport horse breeding
- activities and plans of the EAAP Horse Commission
  - science-to-practice / practice-to-science
  - development and use of the network
  - → implications and prospects for WBFSH and horse breeding

Scientific Collaboration Webinar

EAAP Horse Study Commission

EAAP HC Board*	
	president: Rhys Evans, Norway (2020-2023)
	vice-president: Klemen Potočnik, Slovenia (2019-2022) Roberto Mantovani, Italy (2020-2023) Isabel Cervantes, Spain (2021-2024)
	secretary: Pasquale De Palo, Italy (2021-2024) Jackie Tapprest, France (2021-2024)
	industry representative: Melissa Cox, Germany (2019-2022)
	EAAP Young Club: Juliette Auclair, France (2019-2022) Kirsty Tan, Germany (2020-2023)

- working groups (WG) of the EAAP HC
  - Socio-economy WG
  - Interstallion WG **BREEDING TOPICS**
    - chair: Steven Janssens, Belgium
    - secretary: Kathrin F. Stock, Germany
    - 6-8 members
  - European Workshop for Equine Nutrition (EWEN) WG

* EAAP regulations for board members of Study Commissions: in total max. 3 terms, with max. 2 terms in the same position

EAAP 2021 Conference: overview

- hybrid format with live-stream of all sessions
- figures and facts
  - 1,287 participants from 49 countries
    (approx. 800 participants on-site in Davos)
  - 1,151 abstracts
    → 715 theatre presentations (558 on-site, 157 virtual) plus 332 posters
  - 74 scientific sessions

EAAP 2021 hot topics:

- climate change (challenges, demands)
- environmental responsibility
- food safety and food security
- sustainability of livestock production systems
- resilience, efficiency, welfare

EAAP 2021 Conference: horses

- 3 full sessions (incl. one joint session with study commission for health & welfare)
  - S 08 **Development of genetic and genomic systems in equid breeding** (H; T)
  - S 28 **Evolutions and latest developments in equine production and management** (H; C+T)

    originally: New perspectives and approaches in equidae production (T), and Horse registration, legal status of horses and its consequences (C)
  - S 58 **Animal behavior: From horses to hens** (H+W/H; T)
- 43 accepted abstracts

  → 29 theatre presentations (14 + 10 + 5) plus 14 posters (5 + 9 + 0)

T = theme session (key topics in animal science), C = challenge sessions (free format to debate important issues)

EAAP 2021 – Session 08 Development of genetic and genomic systems in equid breeding (I)

- **Does morphology make the athlete – genetic analysis of Argentine polo horses lines**
  Azcona F, Molina A, Peral García P, Demyda-Peyrás S
- **Estimation of genetic parameters depending on the distance in endurance competitions of horses**
  K.D. Arias KD, J.P. Gutiérrez JP, Cervantes I
- **Young horse competitions as predictors of adult horse performance in endurance races**
  Cervantes I, Sopeña C, Formoso-Rafferty N, Pérez-Cabal MA, Arias KD, Gutiérrez JP
- **Genetic relationship between free movements and under rider gaits in Pura Raza Española horse**
  Ripollés-Lobo M, Perdomo-González DI, Sánchez-Guerrero MJ, Bartolomé E, Valera M
- **Estimation of genetic parameters for 'early life' jumping traits in the Belgian Warmblood horse**
  Chapard L, Meurrens I, Buys N, Janssens S
- **Assessing the value of genetic linear profiles for selecting for sport performance of riding horses**
  Stock KF, Workel I, Hahn A, Schulze-Schleppinghoff W

trait definitions in riding horses
genetic modelling
trait correlations and use of indicator traits

- **Shape and gaits 2.0 – high-precision phenotyping for equine breeding**
  Haraldsdottir EH, Gmel AI, Weishaupt MA, Serra Bragança FM, Druml T, Cruz AM, Neuditschko M
- **Are conformation characteristics of Pura Raza Española adult horses predictable?**
  Gómez MD, Perdomo-González DI, Molina A, Sánchez-Guerrero MJ, Valera M
- **Phenotypic and genetic analysis of conformational defects of the knee in Pura Raza Española horse**
  Ripollés-Lobo M, Perdomo-González DI, Sánchez-Guerrero MJ, Bartolomé E, Valera M

EAAP 2021 – Session 08 Development of genetic and genomic systems in equid breeding (II)

- **Single-step genomic evaluation in German riding horses**
  Wobbe M, Alkhoder H, Stock KF, Liu Z, Vosgerau S, Krattenmacher N, Von Depka-Prondzinski M, Kalm E, Reents R, Nolte W, Kühn C, Tetens J, Thaller G
- **Validating genomic selection for sport traits in Dutch warmblood horses**
  Arts DJG, Bergsma R
- **Microsatellite alleles imputation from SNP genotypes for parentage verification in sport horses**
  Crichan H, Engler C, Goulas E, Dhorne-Pollet S, Addes M, Ricard A
- **Pseudoauthosomal region as a key factor for the molecular detection of Turner´s syndrome in horses**
  Pirosanto Y, Laseca N, Azcona F, Molina A, Valera M, Demyda-Peyrás S
- **Screening for genomic association with fertility in PRE horses using high density genotyping data**
  Laseca N, Demyda-Peyrás S, Perdomo-González DI, Ramón M, Muñoz-Cruzado M, Escribano B, Azor P, M. Valera M, Molina A

use of SNP genotype data and genomic analyses in horses

- **Exploratory whole genome association with fertility in PRE horse breed using chromosome X NGS data**
  Laseca N, Muñoz-Cruzado M, Demyda-Peyrás S, Goszczynski D, Ramón M, Escribano B, Encina A, Valera M, Molina A
- **Inbreeding coefficient estimation methodologies comparison in Pura Raza Española horse population**
  Perdomo-González DI, Molina A, Cervantes I, Laseca N, Demyda-Peyrás S, Valera M

EAAP 2021 – Session 08 Development of genetic and genomic systems in equid breeding (III)

- **Genomics to maintain diversity and robustness of Coldblood breeds**
  Sievers J, Metzger J, Distl O
- **Genetic parameters for new phenotypes measured in Italian Heavy Draught Horse**
  Mancin E, Sartori C, Beniamino Tuliozzi B, Pigozzi G,. Mantovani R
- **GxE and selection response for fertility and linear type traits in Italian Heavy Draught Horse**
  Sartori C, Mancin E, Tuliozi B, Mantovani R

trait definitions, genetic and genomic approaches in Coldblood horses

EAAP 2021 – Session 28 Evolutions and latest developments in equine production and management (I)

- **Equine registration system and (non)use of horsemeat for human consumption: a survey in EU countries**
  Vial C, Santos AS, Evans R, Gras F, Potočnik K
- **Equine end of life in Europe**
  Uldahl M
- **Self-organized equine users: key factors and value of professional services**
  Eslan C, Vial C, Costa S
- **Hay preferences in horses versus selection by their owners**
  Holzer S, Herholz C, Tanadini L, Ineichen S, Juilland S
- **Influence of two feeding managements on behaviour and welfare in horses reared for meat production**
  Raspa F, Vervuert I, De Palo P, Cavallini D, Bergero D, Valvassori E, Valle E
- **An international comparison of prevalence of headshaking syndrome in horses**
  Stange LM, Krieter J, Czycholl I
- **Character testing in Haflinger horses**
  Zanon T, Gruber S, Gauly M
- **Determining objective kinematic parameters to assess ground coverage in Franches-Montagnes horses**
  Gmel AI, Haraldsdottir EH, Serra Bragança FM, Cruz AM, Neuditschko M, Weishaupt MA
- **Traits of interest in performance recording harmonisation of Equus genus – survey results**
  Spehar M, Polak , Santos ASG, Mantovani R, Salimei E, Potočnik K
- **Recent demographic history and genetic diversity in Martina Franca donkey population**
  Landi V, E. Ciani E, De Palo P

specifics of the equid sector and its development
data recording
management aspects

EAAP 2021 – Session 28 Evolutions and latest developments in equine production and management (II)

- **Preventive compression measures on horses' front legs during resting affected surface temperature**
  Hennemann M, Schmid SM, Steinhoff-Wagner J
- **The chicory: a potential crop against summer drought for horses**
  Valleix M, Brossier M, Wimel L
- **Effect of grazing on subcutaneous fat distribution in foals by ultrasound assessment**
  Sarriés MV, Cittadini A, Lorenzo JM, Indurain G, Saez JL, Canals RM
- **Impact of essential oils on insulin sensitivity and the metabolome of insulin dysregulated horses**
  Loos CMM, Vanzant ES, Han W, Zhao S, Li J, Li L, Bohannan AD, Urschel KL, McLeod KR
- **Mare's udder secretory capacity from 3 days to 6 months of lactation**
  Auclair-Ronzaud J, Dubois C, Wimel L
- **Times between foaling and the first standing and suckling of the new-born foal**
  Wimel L, Pégourie C, M. Valleix M, Auclair-Ronzaud J
- **Whether the mares milking process stresses the mares?**
  Polak GM
- **Distribution of minor trace elements in different fractions of donkey milk**
  Fantuz F, Ferraro S, Todini L, Spurio R, Fatica A, Marcantoni F, Salimei E
- **Oxidative stability and volatolomic profile of dry vs vacuum aged horse meat**
  De Palo P, Faccia M, Natrella G, Lorenzo JM, Maggiolino A

management and feeding aspects
lactation and equid products
(milk, meat)

EAAP 2021 – Session 58 Animal behavior: From horses to hens

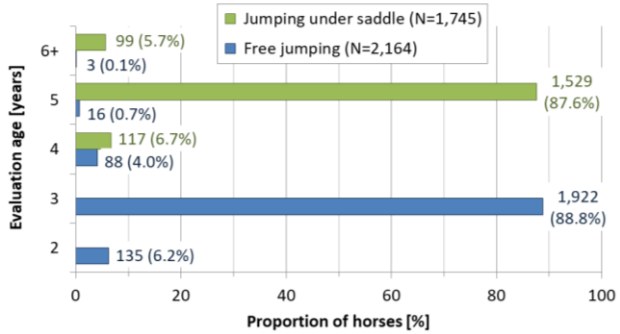
- **New methodological approaches in ethology: social information in equine movement gestalt**
  Wyss C, Dahl CD, Zuberbühler K, Bachmann I
- **Do horses perform social referencing with their owner?**
  Sutter H, Briefer Freymond S, Maigrot A-L, Bachmann I
- **Do rider-horse pairs have similar personality traits?**
  Briefer Freymond S, Maigrot A, Sutter H, Chariatte C, Bachmann I
- **The relationship between upper body motion and vertical ground reaction forces in trotting horses**
  Roepstorff C, Gmel A, Arpagaus S, Serra Bragança FM, Roepstorff L, Weishaupt MA
- **Head and neck position and behaviour in ridden elite dressage horses in warm-up and test situation**
  Kienapfel-Henseleit K, Piccolo L, Reulke R, Rueß D, Bachmann-Rieder I

recording und use of sensor data horse-human interaction

Chapard L, Meurrens I, Buys N, Janssens S:

Estimation of genetic parameters for 'early life' jumping traits in the Belgian Warmblood horse (I)

- analysis of linear jumping traits across presentation types
  → usability of 'early life' jumping records in breeding
- data collection
  - assessment of jumping capacity at young age
    → 11 traits (jumping, canter), 9-point linear scale
  - 3,719 BWP horses: free jumping since 2003 (FJ, N=2,164), jumping under saddle since 2014 (SJ, N=1,745)
- genetic analyses of FJ and SJ traits
  - model: sex, age; contemporary group (date, place, appraiser)
  - multivariate setting: FJ, SJ, pairwise FJ-SJ



Trait
Scope
Take-off
Technique of forelegs
Technique of back
Technique of haunches
Attitude (willingness)
Care
Stride length of canter
Impulsion
Elasticity of canter
Balance

Chapard L, Meurrens I, Buys N, Janssens S:

Estimation of genetic parameters for 'early life' jumping traits in the Belgian Warmblood horse (II)

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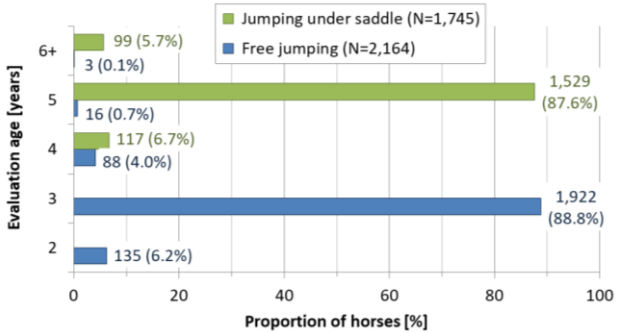
- genetic analyses of FJ and SJ traits
  - model: sex, age; contemporary group (date, place, appraiser)
  - multivariate setting: FJ, SJ, pairwise FJ-SJ
- similar heritabilities (h^2) of 0.17 for FJ and 0.16 for SJ, variation between contemporary groups larger for SJ than FJ, **strong positive additive genetic correlations FJ - SJ**
- predictive value for ranking in sports to be investigated

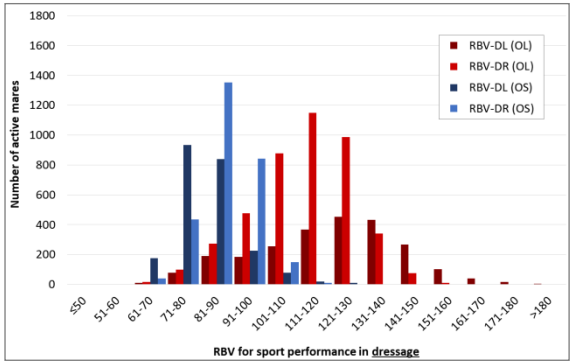


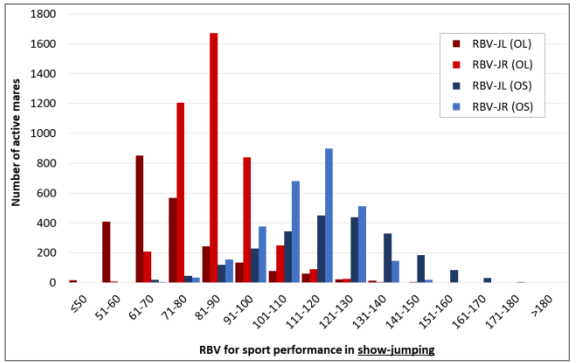
Trait	h^2_{FJ}	h^2_{SJ}	r_g
Scope	0.30	0.20	**+0.87**
Take-off	0.20	0.14	**+0.85**
Technique of forelegs	0.18	0.10	**+0.77**
Technique of back	0.17	0.12	**+0.70**
Technique of haunches	0.22	0.20	**+0.73**
Attitude (willingness)	0.04	0.08	+0.57
Care	0.14	0.09	+0.58
Stride length of canter	0.17	0.29	**+0.84**
Impulsion	0.22	0.22	**+0.86**
Elasticity of canter	0.09	0.15	+0.54
Balance	0.13	0.19	+0.68

Stock KF, Workel I, Hahn A, Schulze-Schleppinghoff W:

Assessing the value of genetic linear profiles for selecting for sport performance of riding horses (I)

- suitability of linear profiles to select for sport performance
  → genetic correlation analysis
- data
  - results of routine genetic evaluations
    → estimated breeding values for linear traits (studbooks OL+OS) and for sport traits (German riding horses)
  - linear description: **conformation, performance**
    → 27,786 linear profiles; 46 traits
  - sport performance: **dressage, show-jumping**; rank, highest level
    → D 5.8m starts / 266k horses, J 13.2m / 311k horses; 4 traits
- study sample
  - results of routine genetic evaluations 2020 for OL/OS mare population (N_{LIN}=10,768, N_{sport}=7,198)
  - about 600 mares with own performance and/or at least 2 adult progeny (EBV reliabilities ↑)

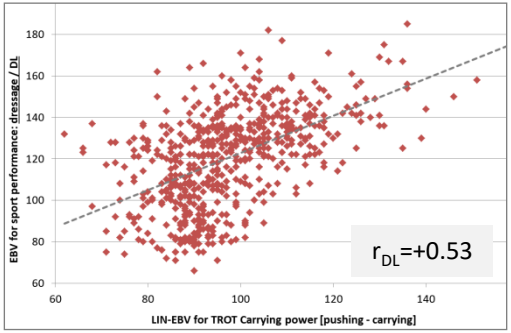


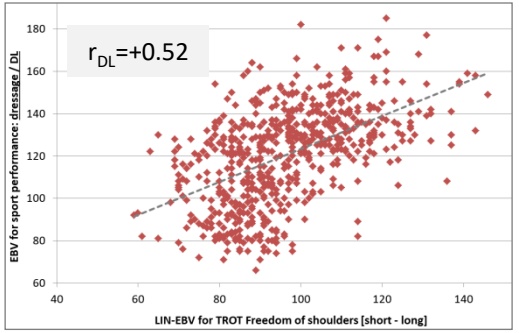


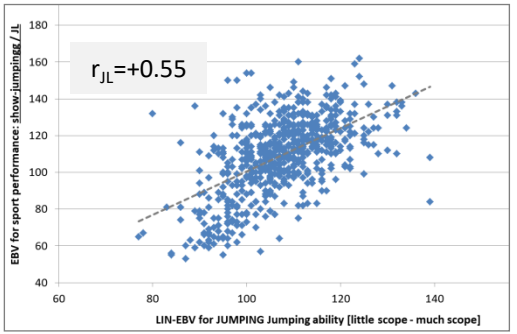
Stock KF, Workel I, Hahn A, Schulze-Schleppinghoff W:

Assessing the value of genetic linear profiles for selecting for sport performance of riding horses (II)

- …
- EBV correlations (proxy of genetic correlations) and analyses of variance
- results
  - conformation: some functionally plausible correlations (dressage)
  - performance: within discipline mostly significant correlations ($P < 0.001$)
  - ANOVA: slightly different patterns for sport trait definitions L and R
- implications: **suitability of the linear system to strengthen sport horse breeding programs** (genetics, genomics)







Linear trait group	Pearson correlation coefficients		Indicator value
	D (DL, DR)	J (JL, JR)	
Conformation, special remarks	-0.26 to +0.32	-0.14 to +0.21	?
Gaits	+0.12 to +0.53	-0.37 to +0.28	D+
Jumping	-0.51 to -0.25	+0.09 to +0.55	J+

Wobbe M, Alkhoder H, Stock KF, Liu Z, Vosgerau S, Krattenmacher N, Von Depka-Prondzinski M, Kalm E, Reents R, Nolte W, Kühn C, Tetens J, Thaller G:

Single-step genomic evaluation in German riding horses (I)

- development of routine genomic evaluation for sport horses
  → validation results for linear conformation and gaits traits
- approach
  - collaboration of studbooks
    → across-breeds set-up
  - single-step method allowing integration of all available data
- data: phenotypes + pedigree + genotypes
  - **linear profiles** (foals, adult horses; uniform linear system)
    → approx. 41,500 linear profiles (2012-2019)
  - phenotyped horses + 5 generations (approx. 116,500)
  - genotype data: reference population of 5,000 horses with **70k+ SNP genotypes** (N = 4,964 after QC)
  - single- / multiple-trait linear animal model
    (as in routine genetic evaluation; sex, age, event-team, presentation type)

foals:

$$y_{ijklop} = \mu + SB_i + EVENT\text{-}TEAM_j + AGE\_M_k + SEX_l + animal_o + e_{ijklop}$$

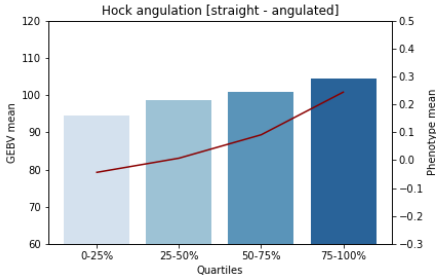
mares / sires:

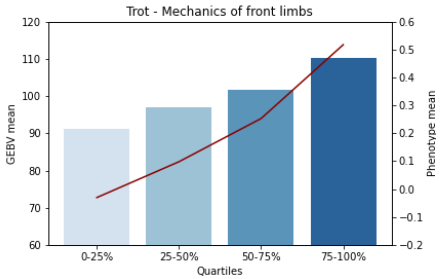
$$y_{ijmnop} = \mu + SB_i + EVENT\text{-}TEAM_j + AGE\_Y_m + PTYP_n + animal_o + pe_o + e_{ijmnop}$$

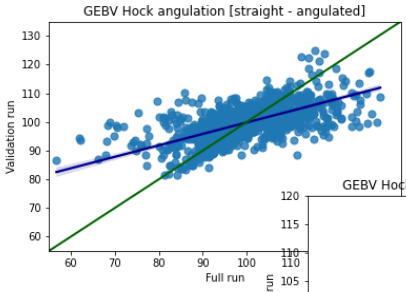
Wobbe M, Alkhoder H, Stock KF, Liu Z, Vosgerau S, Krattenmacher N, Von Depka-Prondzinski M, Kalm E, Reents R, Nolte W, Kühn C, Tetens J, Thaller G:

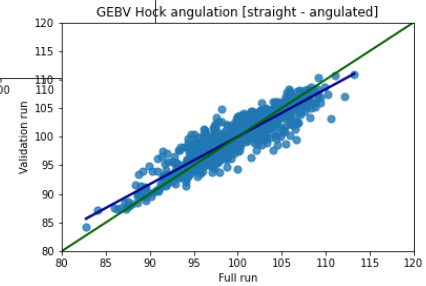
Single-step genomic evaluation in German riding horses (II)

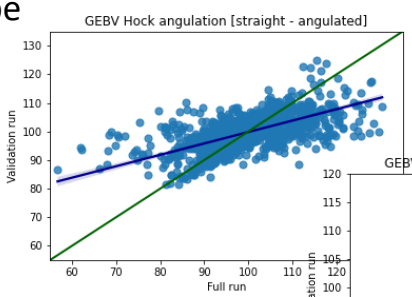
- …
- validation
  - cross-validation: balanced random assignment (10x);
    training set, validation set (15%, approx. 2,140 horses; prediction)
  - forward-prediction: assignment by year
    (validation animals = horses linearly described after 2017)
  - quartile statistics: mean gEBV, mean offspring phenotype
- <u>implications:</u> stability of the ssGE system;
  minor differences between studbook (cross val.)

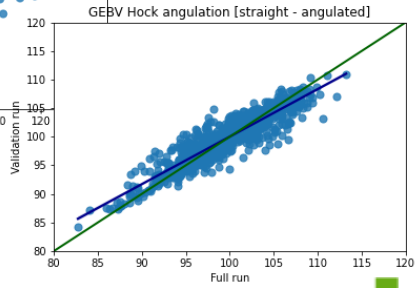












Arts DJG, Bergsma R:

Validating genomic selection for sport traits in Dutch warmblood horses (I)

- sport traits as targets of genomic evaluation
  → added value (increase of accuracy) of breeding values
- data
  - **SNP genotypes** (75k) of about 20,000 horses
    → different types, mostly young horse with no sport data (yet)
  - **selected stallions**: born since 2003, specialized breeding program, at least 30 offspring in sport → 52 stallions
- method
  - comparison of results of test runs: genetic evaluation (BLUP / EBV) and genomic evaluation (ssGBLUP /gEBV)
  - leave-one-out technique: exclusion of (grand-)offspring data of one stallion at a time → 52 runs BLUP + 52 runs ssGBLUP

Trait	N total	N (%) genotyped
Sport	68,063	2,150 (3%)
One-day-field test (IBOP)	8,183	1,139 (14%)
Gradings	59,645	3,394 (6%)
Performance test (EPT)	5,292	458 (9%)
total	109,410	4,273 (4%)

Multiple-trait setting:
- **Sport** – highest level achieved (transformed)
- **One-day-field test (IBOP)** – gaits, rideability, balance, technique, scope (under saddle, own rider, single test day; scores 1-10)
- **Gradings** – sport ability (mares, stallions; general score 1-100)
- **Performance test (EPT)** – gaits, rideability, balance, technique, scope (under saddle, test rider, test period of 3-7 weeks; scores 1-10)

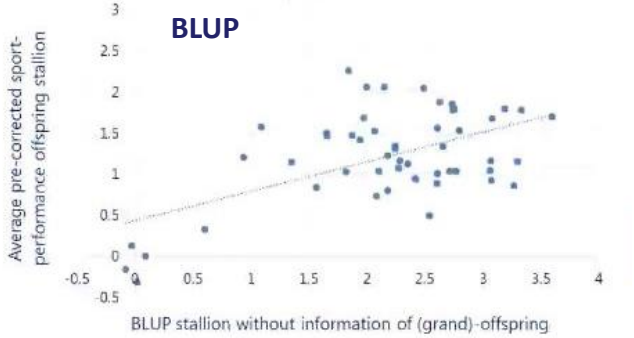
Arts DJG, Bergsma R:

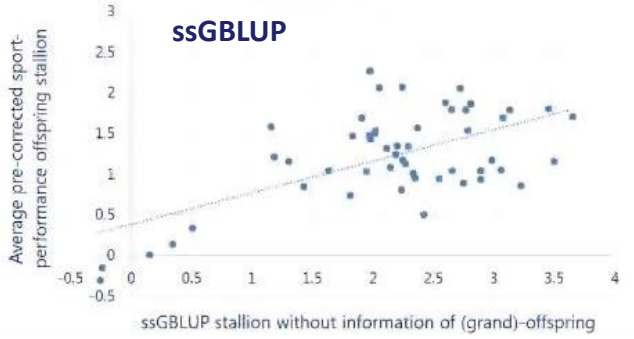
Validating genomic selection for sport traits in Dutch warmblood horses (II)

- …
- validation
  - EBV (gEBV) vs. average pre-corrected sport performance of offspring of the respective stallion
  - accuracy of breeding values = weighted Pearson correlation
  - weighting factor relating to heritability of the target trait
- **increase of accuracy of breeding values by genomics**: +4.6% (when omitting also own performance: +7%)
- ➢ more research needed to evaluate lower than expected slope
  - over-/underestimated heritability?
  - non-random sample of stallions

+0.046

Validation criterion	BLUP	ssGBLUP
Weighted Pearson correlation	0.548	0.594
Weighted regression (slope) - should be 0.5	0.350 (SE 0.08)	0.379 (SE 0.07)





Arts DJG, Bergsma R:

Validating genomic selection for sport traits in Dutch warmblood horses (III)

- …
- greatest benefit of genomic evaluation at young age implying valuable decision support
- ➢ planned implementation of single-step genomic evaluation in KWPN in the near future

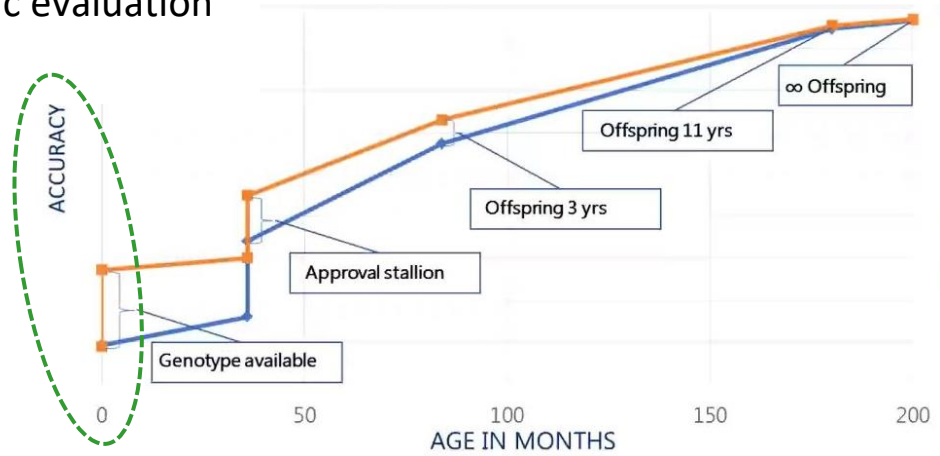
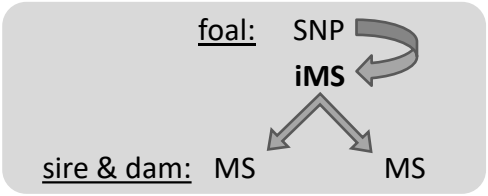


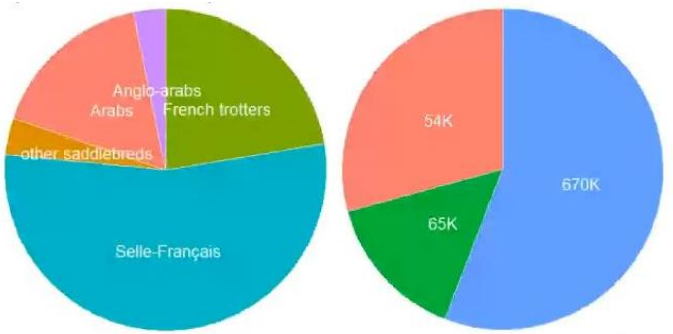
Illustration of the expected development of accuracy of EBV and gEBV during the career of a horse

Crichan H, Engler C, Goulas E, Dhorne-Pollet S, Addes M, Ricard A:

Microsatellite alleles imputation from SNP genotypes for parentage verification in sport horses (I)

- transition from microsatellite-based parentage verification to directly SNP-based parentage verification
  → prediction of microsatellites (MS) using SNP data
- data collection
  - 5,892 horses with MS data and genome-wide SNP data
  - multiple breeds
    → Selle-Français >> French Totters, Arabs, others
  - different SNP chips (54k, 65k, 670k)
    → heterogeneous marker densities
  - consideration of 11 MS
- principle:
  - 'translation' of the information content of markers





Distributions by breed (left) and SNP chip size (right) illustrating the challenging data structure

Crichan H, Engler C, Goulas E, Dhorne-Pollet S, Addes M, Ricard A:

Microsatellite alleles imputation from SNP genotypes for parentage verification in sport horses (II)

- …
- method (McClure et al. 2012, 2013)
  - SNPs +/- 500kbp on either side of the MS
    → 111-314 SNPs per MS (total: 1,908 SNPs)
  - translation of multi-allelic MS in bi-allelic markers
  - cross-validation: training set (4/5; correspondence table)
    → validation set (1/5; MS prediction)

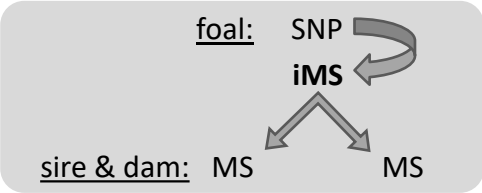


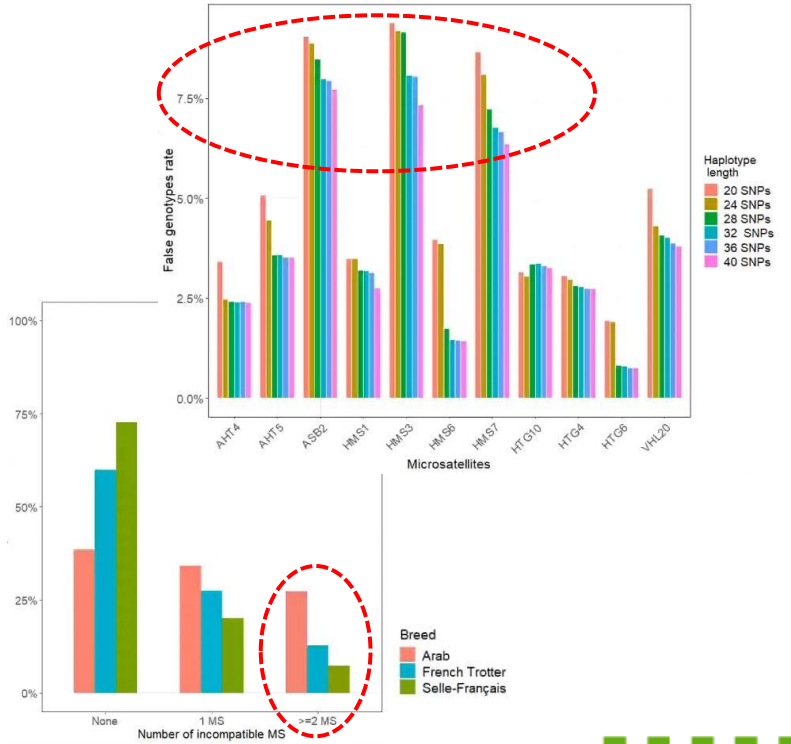
Illustration of the principle of MS imputation: translation of the information content of markers

Crichan H, Engler C, Goulas E, Dhorne-Pollet S, Addes M, Ricard A:

Microsatellite alleles imputation from SNP genotypes for parentage verification in sport horses (III)

- …
- results
  - obvious impact of the data structure
  - false genotypes rates > 5% for 3 MS
  - 12.4% incompatibilities (>1 MS) = 'rejected offspring'
    → re-genotyping rates of 7.3% (SF) to 27.3% (Arab)

  ⇒ differences between breeds and influence of SNP density
  (sub-set of horses with 670k SNPs: 3.4% incompatibilities)
- ➢ further work to be done
  (training data ↑, genotyping strategy for French sport horses)



Note from the discussion:
necessary exchange between French and German groups
(routine MS imputation in German sport horses based on 80k SNPs with re-testing rate of 1.5%)

Haraldsdottir EH, Gmel AI, Weishaupt MA, Serra Bragança FM, Druml T, Cruz AM, Neuditschko M:

Shape and gaits 2.0 – high-precision phenotyping for equine breeding

- measurements of conformation and gait quality
  → objective trait definitions for advanced analyses (within and across European horse breeds)
- data collection
  - Horse Shape Space model (photographs, side view)
    → shape and joint angle measurements
  - DNA sampling → genome-wide SNP genotypes (670k)
  - limb length measurements
  - EquiMoves® sensors (walk, trot; 30-35m)
    → stride length, stride frequency, protraction / retraction angles (FL, HL), vertical displacement of the withers, speed
- image-based measurements: objective, cost-efficient
- gait quality measurements: more complex, challenging (time-consuming, expensive, requiring expertise)

Resources:
- 30 min (for runway preparation) + 2.5 h per horse (30 min for measurements, 2h for data post-processing)
- 4-5 persons (2 for photographs, 2-3 for EquiMoves®)

Data types	FM	SWB	LIP	SHA	PRE
shapes	623	32	224	32	19
gait traits	234	32	0	0	0
SNP genotypes	510	32	224	32	19

FM = Franches Montagnes, SWB = Swiss Warmblood, LIP = Lipizzaner, SHA = Shagya Arabian, PRE = Pura Raza Español

Further EAAP activities

- monthly webinars
- one-day-workshops and industry sessions at the EAAP annual meetings

➢ options of joint activities of EAAP HC with WBFSH

vit

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Animal Production

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WBFSH

Thank you!

EAAP · EUROPA · FEZ · EVT
EAAP
European Federation of Animal Science

The Horse Study Commission

EAAP 2021 Video recordings

- slides and all pre-recorded presentations to become available in the individual members' section at https://www.eaap.org/
  (free registration for individual membership for everyone interested)
- some material already freely available online at
  https://www.equinephenotypes.org/ (section publications)