Modernizing U.S. Calving Ease Evaluation Under Single-step

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ICAR2026
VERONA ITALY

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Drivers for change

1. **Transitioning to single-step**
   CDCB is moving to single-step genomic evaluation

2. **An opportunity (and necessity)**
   The transition is a chance to revisit all trait group models

3. **Calving traits need deeper revision**
   Specific features warrant more attention than other trait groups

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The current evaluation

- Developed in 2003, reviewed in 2005 and 2019
- Dedicated stand-alone pipeline (databases and software)
- Calving ease phenotypes **4 categories**
  1 no problem; 2 slight problem; 3 needed assistance; 4 considerable force; 5 extreme difficult (4&5)
- Data from 1980, for Holstein and Brown Swiss
- **Single-trait**: calving ease on first and later parities treated as same trait
- **Sire-MGS threshold model**
- Service Sire and Daughter Calving Ease PTA (**dce***, **mce***)
  as % difficult calvings in first parity

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ICAR/Interbull guidelines

Recommendations on calving traits harmonization

- ✓ **Multi-trait**
  First and later parities as separate traits
- ✓ **Animal model preferred over Sire-MGS**
  With direct and maternal genetic effects
- ✓ **Snell transformation**
  Applied if a linear model is used
- ✓ **Submit first-parity direct and maternal proofs to MACE**
  Recommended criterion

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What we set out to do

- **Multi-trait** (first vs later parities)
- Replacing sire-MGS with **sire-dam**
  (animal model not feasible due to missing calf IDs)
- **Phenotype cutoff** reducing missing dams
- **All-breeds** phenotypes
  including most common crossbreds (excluding BxD)
- Unique across-traits pipeline
  e.g. MF, Blupf90 software

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Linear Model Option

- Goals:
  - Unified approach across traits groups
  - Straightforward integration of MACE proofs in single-step evaluation
- VCE **multi-trait**, **sire-dam**:
  $r_g(dce_{1st}, dce_{Later})$ = **0.76**; $r_g(mce_{1st}, mce_{Later})$ = **0.75**

(Snell score transformation tested and dropped)

✗ Converge issues in single-step GBLUP

✗ Unsuccessful conversion from linear EBVs to probability (Padilha et al., 2026): US dairy industry expects probabilities

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Threshold Model Option

- VCE **multi-trait**, **sire-dam**:
  $r_g(dce_{1st}, dce_{Later})$ = **0.95**; $r_g(mce_{1st}, mce_{Later})$ = **0.92**
- Thresholds:
  1st parity = 0, 1, 1.85
  Later Parities = 0, 1, 1.87

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Candidate Model

- **Single-trait threshold model, sire-dam**
  Newton-Raphson MAP method (Berman et al., 2026)

$$y = SEX + YS + (dam\_age \times parity) + \Sigma_{\mathrm{a}}\Sigma_{\mathrm{b}} q_{S,a} q_{D,b} + HY + S + D + PE + e$$

- Genetic parameters:
  h^2_direct = **0.05**; h^2_maternal = **0.09**; $r_{\mathrm{g\_dir,mat}}$ = **−0.17**

Data

Dec 2023
Evaluation (2312)

23.3M
Phenotypes (~35% 1st parity)

17.8M
Animals in pedigree

103
MF (breed, yob, sel path, ≥1,000 obs)

965k
Informative genotypes

38,968
APY core animal

Software: Blup90iod3 **Evaluations:** Pedigree-BLUP & single-step GBLUP, without MACE integration

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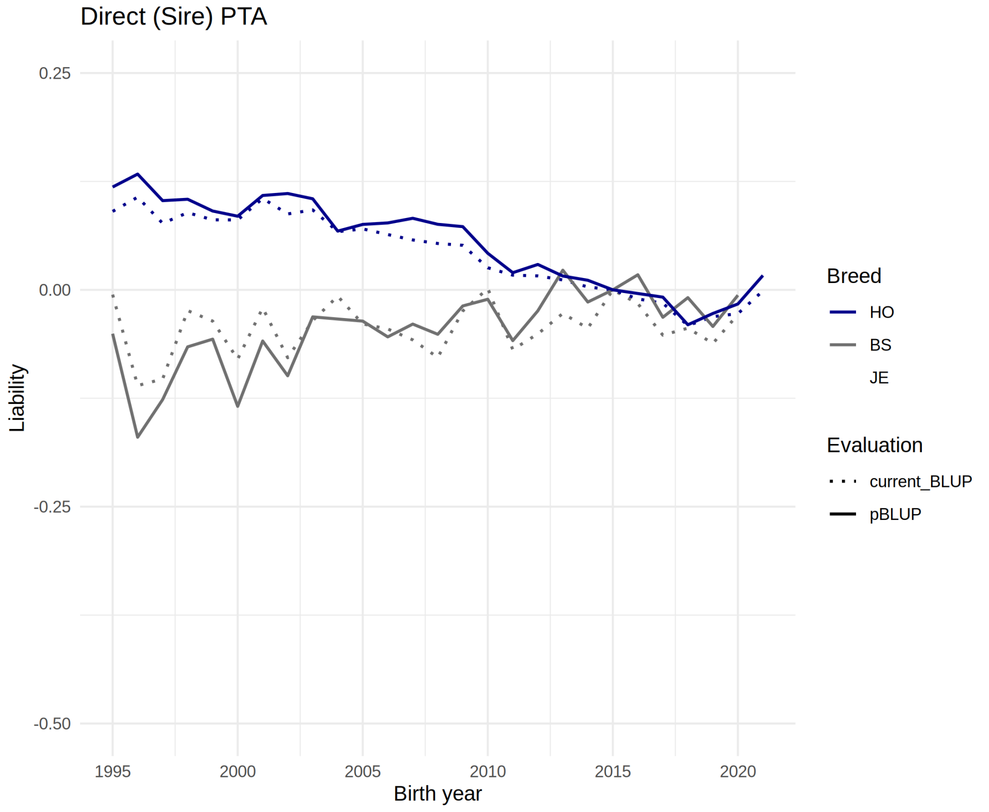
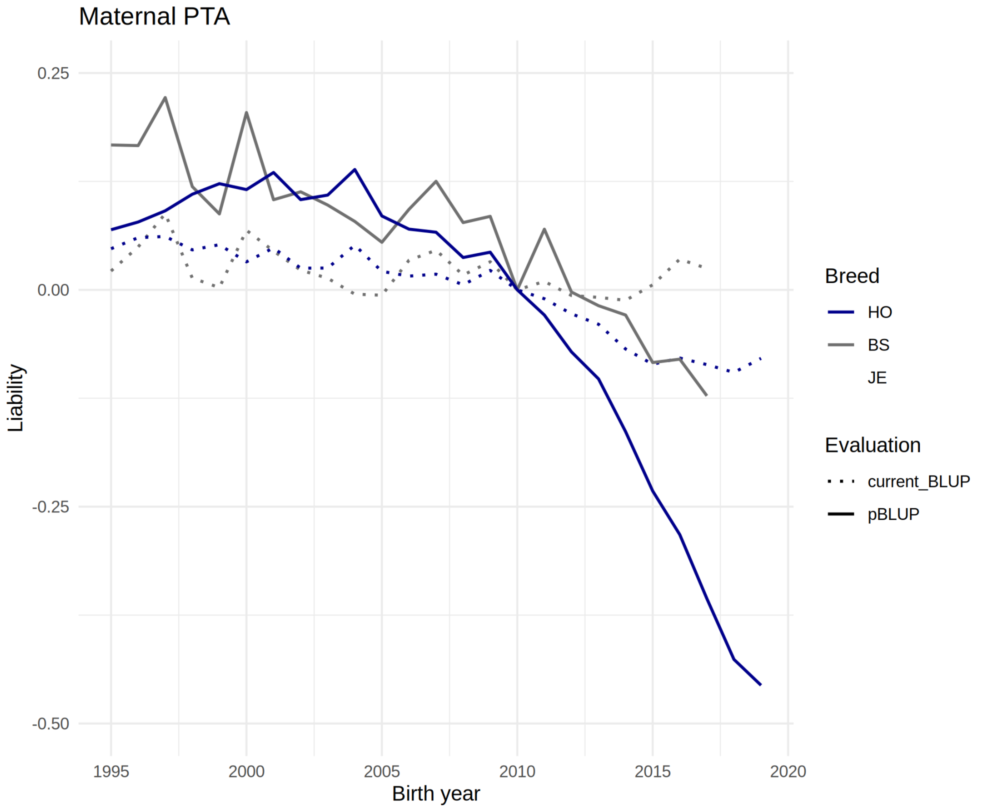
Genetic trends (liability) pBLUP vs current_BLUP (domestic)



Sires >= 25 calves; genetic base 2015



Sires >= 25 daughters; genetic base 2010,
PTAm_s-mgs = (MGS-SIRE/2); PTAm_s-dam = (DAM-SIRE)/2

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Correlations
pBLUP vs current_BLUP (domestic)

	HO		BS	
	n. bulls	r	n. bulls	r
Direct (Sire) PTA [a]	27,518	0.87	682	0.81
Maternal PTA [b,c]	27,115	0.84	391	0.70

[a] Sires born >= 1995 with > 25 calves;
[b] Sires born >=1995 with > 25 daughters
[c] PTAm_s-mgs = (MGS-SIRE/2); PTAm_s-dam = (DAM-SIRE)/2

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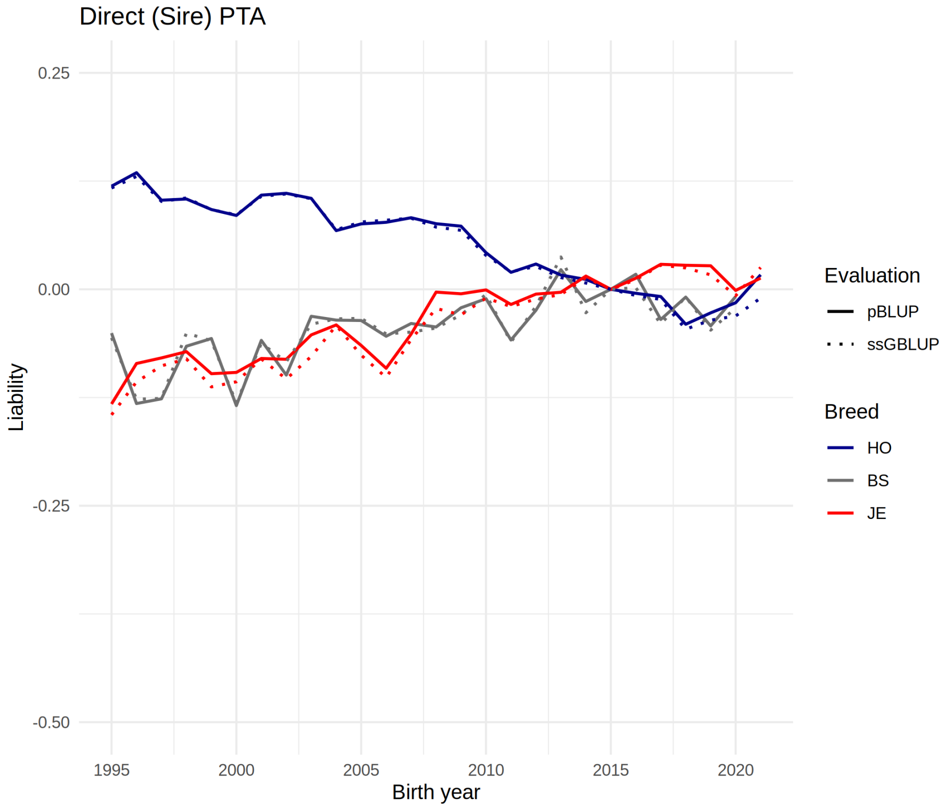
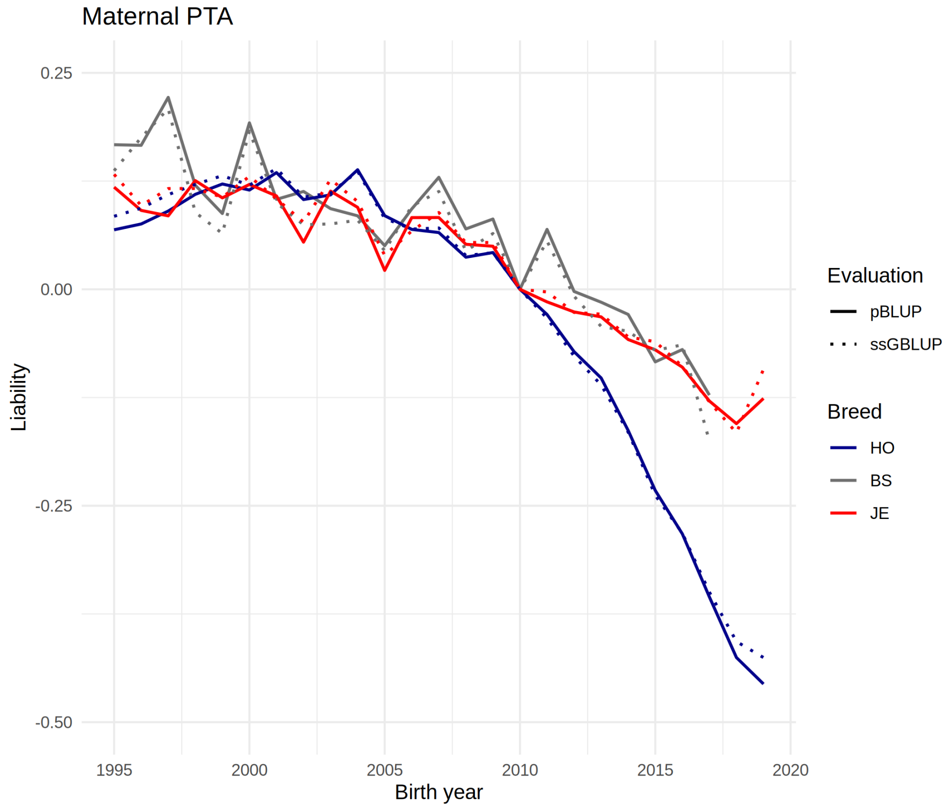
Genetic trends (liability) pBLUP vs ssGBLUP


Direct (Sire) PTA

Sires >= 25 calves; genetic base 2015


Maternal PTA

Sires >= 25 daughters; genetic base 2010,
PTAm_s-mgs = (MGS-SIRE/2); PTAm_s-dam = (DAM-SIRE)/2

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Ongoing investigations

1. **Results & stability across evaluations**
   How much do the EBVs change from run to run?
2. **Integration of MACE proofs**
   Bringing international evaluation into the single-step framework
3. **Genetic & phenotypic base definition**
   For PTA expression on the production scale

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