The benefits of genomics in small populations: case study of type traits in the Dual-Purpose Blue cattle breed

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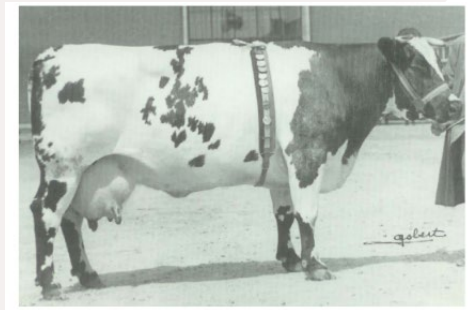
History of a Transboundary breed



1890

Durham Shorthorn crosses to improve local cattle in BEL (Mid and Upper Belgium Breed)

1923

Creation “Bleue du Nord” herdbook

1945

“Rapport Quittet”

1953

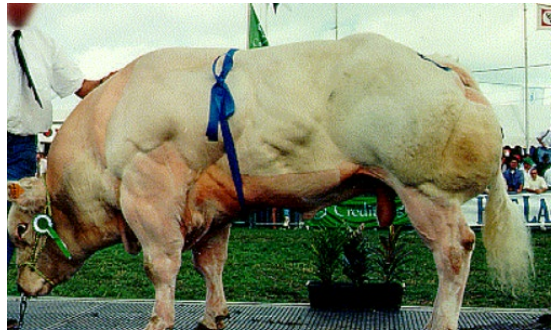
Closure of Bleue du Nord herdbook

1970

Creation of a single national herd book (Blanc Bleu Belge)

1974

Separation in two branches, Beef Belgian Blue (BBB) and Dual-Purpose Blue (DPB)



1983

Official recognition (again) of Bleue du Nord breed

2008 – 2013
2018 – 2022

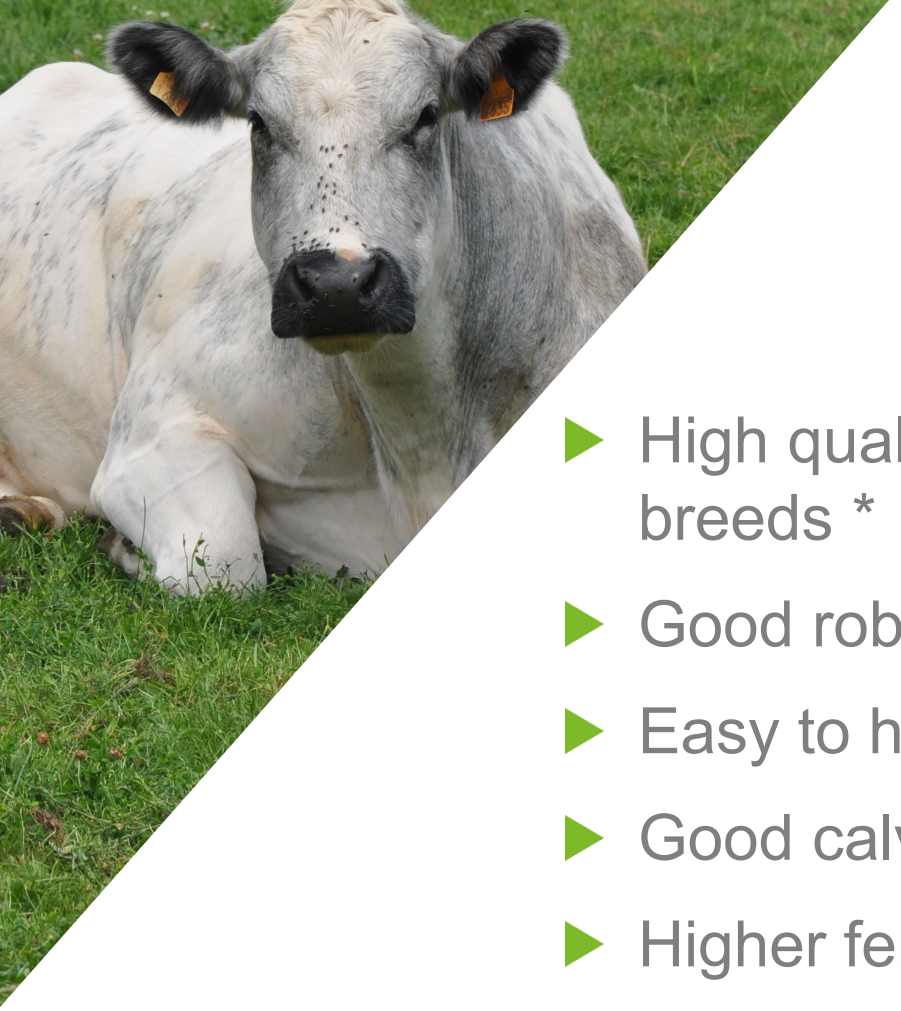
BlueSel & BlueSter transboundary INTERREG projects

BlueSel and BlueSter INTERREG projects

- Preservation of the local transboundary breed
  - Selection & conservation program
  - Development of common genomic evaluation (FR – BEL)

- Valorisation of the breed through the creation of labelled local products

La Divine Bleue
Saveurs de nos campagnes



Why preserve this dual-purpose breed?

- High quality milk compared to high-output international breeds *
- Good robustness
- Easy to handle
- Good calving ease
- Higher fertility and longevity
- **However:**
  - Relatively lower lactation performance
  - No selection yet for morphology

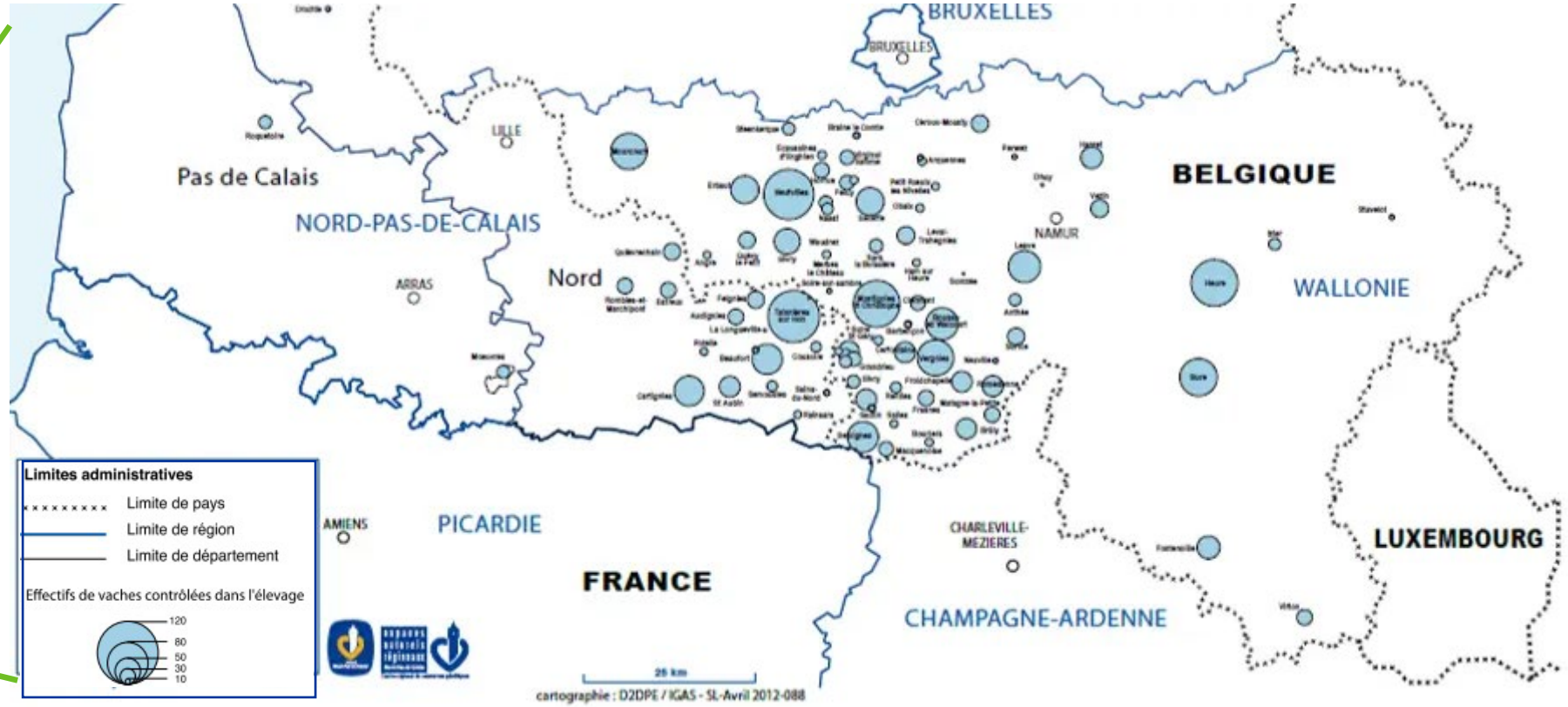
*Soyeurt (2006). J. Dairy Sci., 89, pp. 4858-4865
*Bastin (2020). EAAP meeting

Goal of this study

- Assessment of the gain in reliability for morphology type traits of the Dual-Purpose Blue cattle breed when genomic information is added

The population

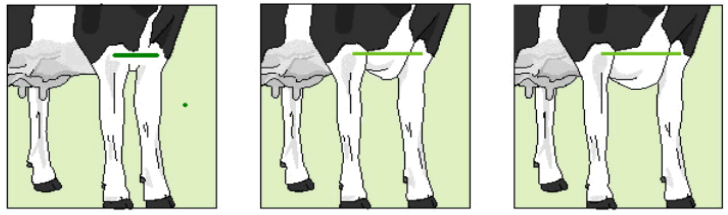
- Only a small breed population left



2: Chest Width

Ref. Point: Measured from the inside surface between the top of the front legs.

1 Narrow
5 Intermediate
9 Wide

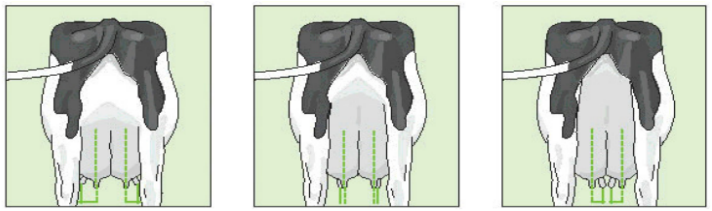


1 Narrow | 5 | 9 Wide

11. Front Teat Placement

Ref. point: The position of the front teat from the centre of quarter as viewed from the rear.

1 Outside of quarter
5 Intermediate
9 Inside of quarter



1 Outside | 5 | 9 Inside

Linear classification of type traits

- 23 type traits evaluated
  - 5 overall traits

    (udder, development, feet and legs, muscularity, rump)
  - 18 individual traits

    (stature, chest depth, udder balance, udder depth, rear udder, front teat placement, teat length, shoulder muscularity, back muscularity, hindquarter muscularity, rump width, rump angle, tail attachment, bone structure, skin fineness, top line, rear leg side view, foot angle)
- Score 1 → 9 (except stature)
- First and second lactation animals

2: **Chest Width**
Ref. Point: Measured from the inside surface between the top of the front legs.

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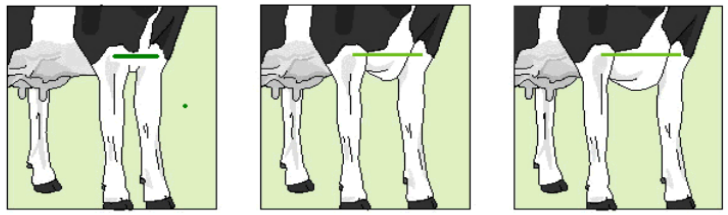
9 Wide



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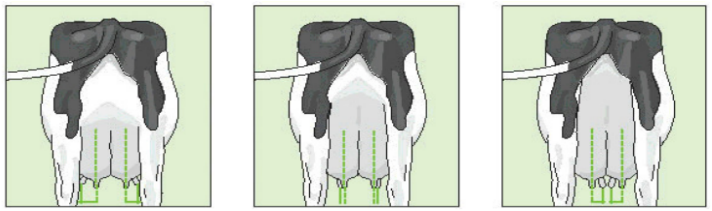

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Linear classification of type traits

- 10,753 animals have classification data available
- Period: 2006 – 2024
- Classification data are provided by France and Wallonia (Belgium)
  - 15% from France → Maison de l'élevage du Nord
  - 80% from Wallonia → Walloon Breeders Association (AWE – Elevéo)

Genotyping and pedigree extraction

- 2,244 genotyped animals
  - 10% from France
  - 90% from Wallonia (Belgium)
- 28,466 common SNP markers across different chips
- Extraction of ancestors out of the database used for the official Walloon genetic evaluation (1x year)

→ pedigree file of 14,379 animals

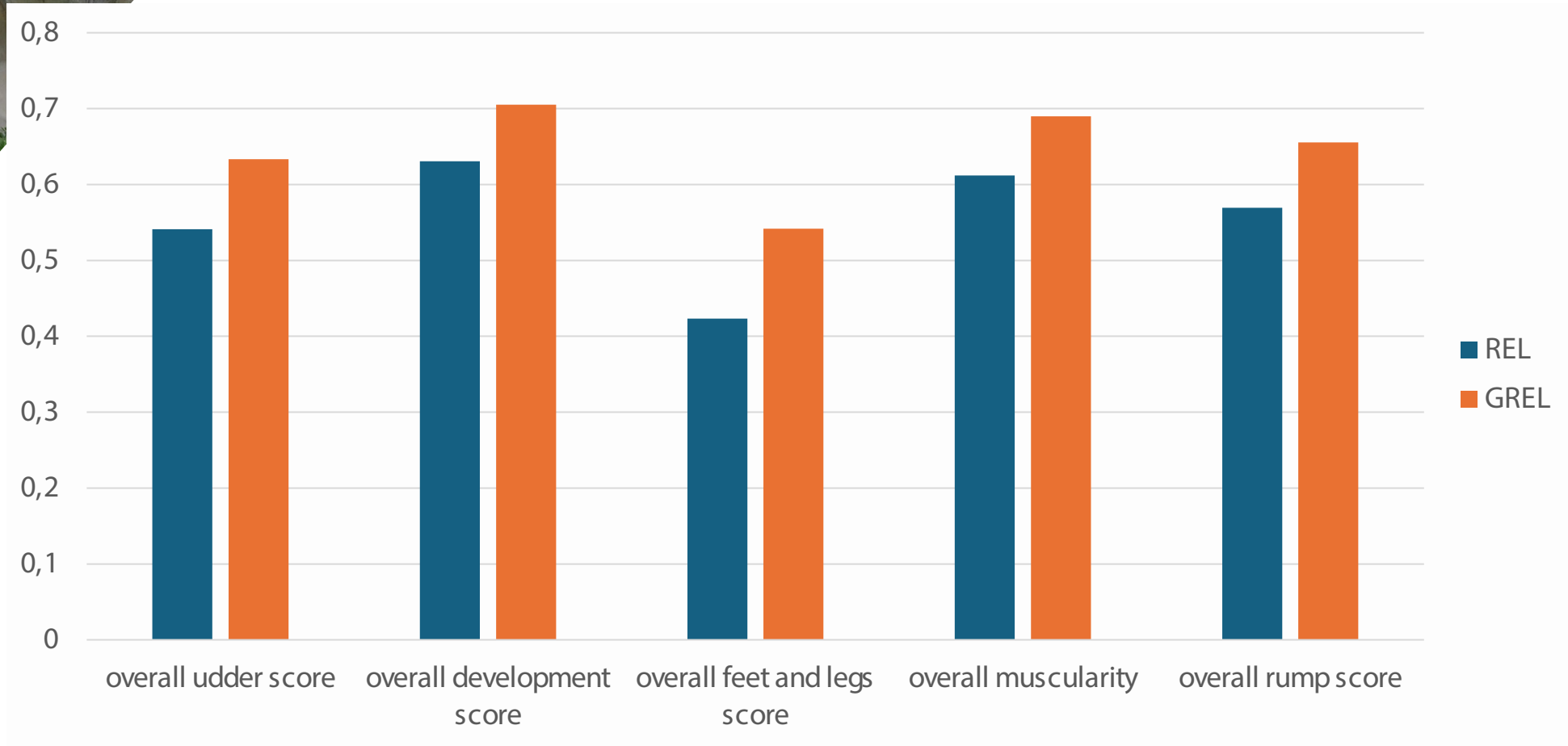
Genomic evaluation

- 1) Multiple-trait animal model→ EBV & associated REL
  - Fixed effects: herd-year-month of classification x classifier-system contemporary group effect, age, lactation stage
  - Random effects: animal and perm.env. (repetitions)

- 2) Pseudo-single step GBLUP with Bayesian integration → GEBV & associated GREL
  - Bayesian approach as proposed by Vandenplas et al. (2014) and used by Colinet et al. (2018), but only limited to local data

Vandenplas (2014). Genet. Sel. Evol. 46(1):5
Colinet (2018). Animal 12(5):898-905

Improvement of REL for genotyped animals (n=2244)



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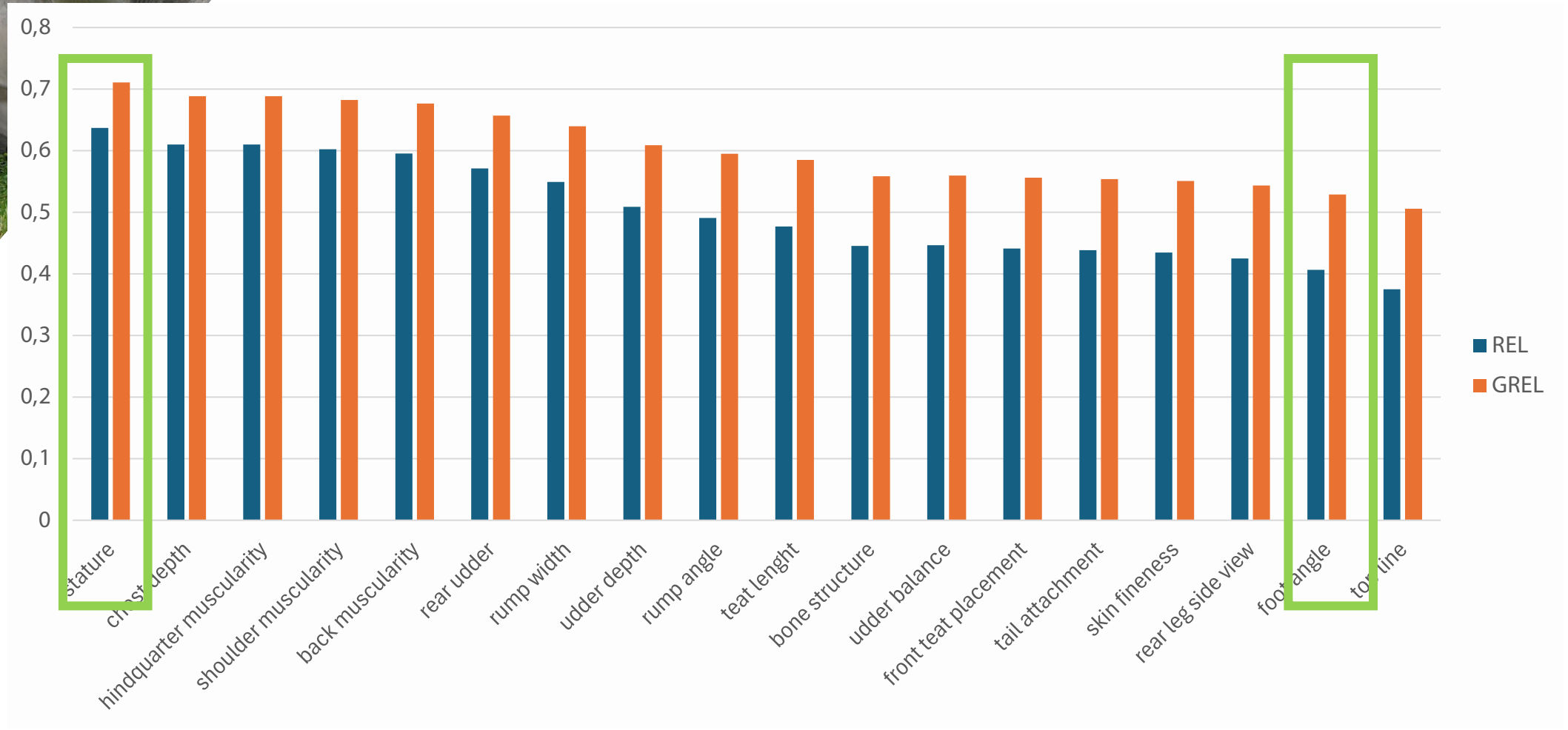
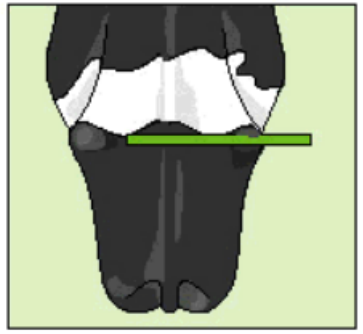


Focus on Stature

- Low difference between REL and GREL (0.072)
- Trait with a high heritability (0.74)

Trait	N	Mean	Std Dev	Min	Max
REL	2244	0.637	0.234	0	0.990
GREL	2244	0.710	0.166	0.153	0.990



Focus on Foot Angle

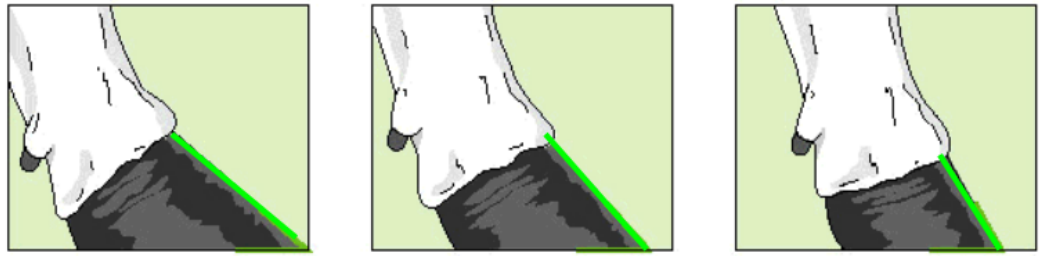
- High difference between REL and GREL (0.123)
- Trait with a low heritability (0.15)

9. Foot Angle

Ref. point: Angle at the front of the rear hoof mea
the right hoof.

1 Very low angle
5 Intermediate
9 Very steep

Trait	N	Mean	Std Dev	Min	Max
REL	2244	0.406	0.151	0	0.930
GREL	2244	0.528	0.112	0.127	0.934



1
Low

5

9
Steep

What about our Bull selection candidates?

- Genotyped bulls with a mean REL < 0.45
  - Stature

Trait	N	Mean	Std Dev
REL	395	0.332	0.123
GREL	395	0.508	0.093

  - Foot angle

Trait	N	Mean	Std Dev
REL	496	0.265	0.103
GREL	496	0.438	0.086

Conclusions

- Enhancements of REL as expected when adding genomic information, even in a small population
- Better selection decisions possible especially in a breed with fewer descendants
- Strategy can be improved → full single-step

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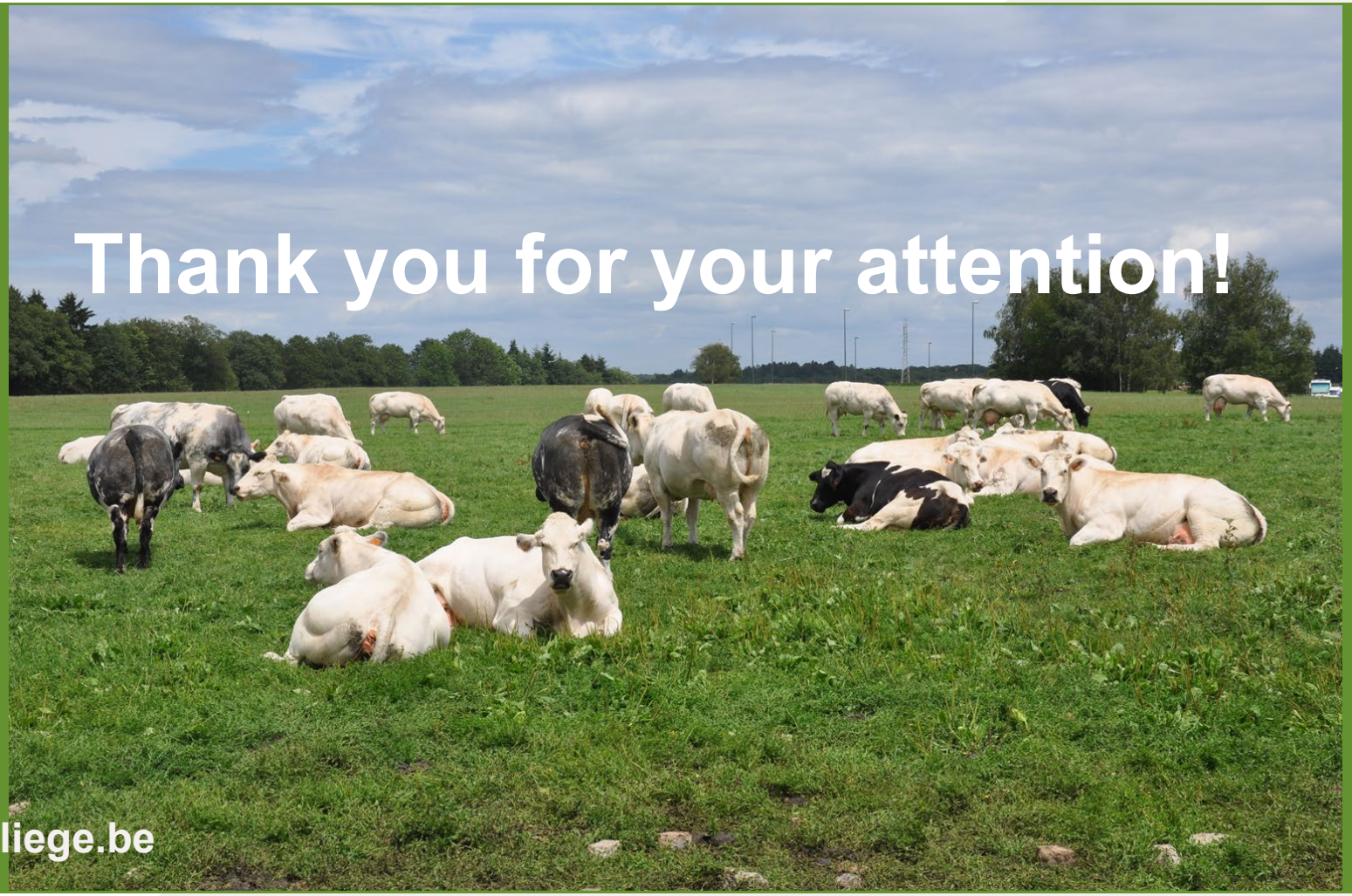
Avec le soutien de la Wallonie



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