Next steps towards the development of a collaborative genomic evaluation system for residual methane production in Walloon Holstein cows

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Steps Towards Genomic Evaluation for CH_4

- Breeding goal
  - Trait definition
- Phenotype
  - Data recording
- Model setup and genetic parameter estimation
- Genetic ➔ genomic evaluation system
  - Setup and running of routines
- Breeding program

Ongoing (slow) process

Today

- Current status of implementation in Holstein
- First results ➔ ability to estimate EBV
- Updates on the link between CH_4 and other evaluated traits
- Future developments

Definition of CH_4 Traits in Dairy Cows

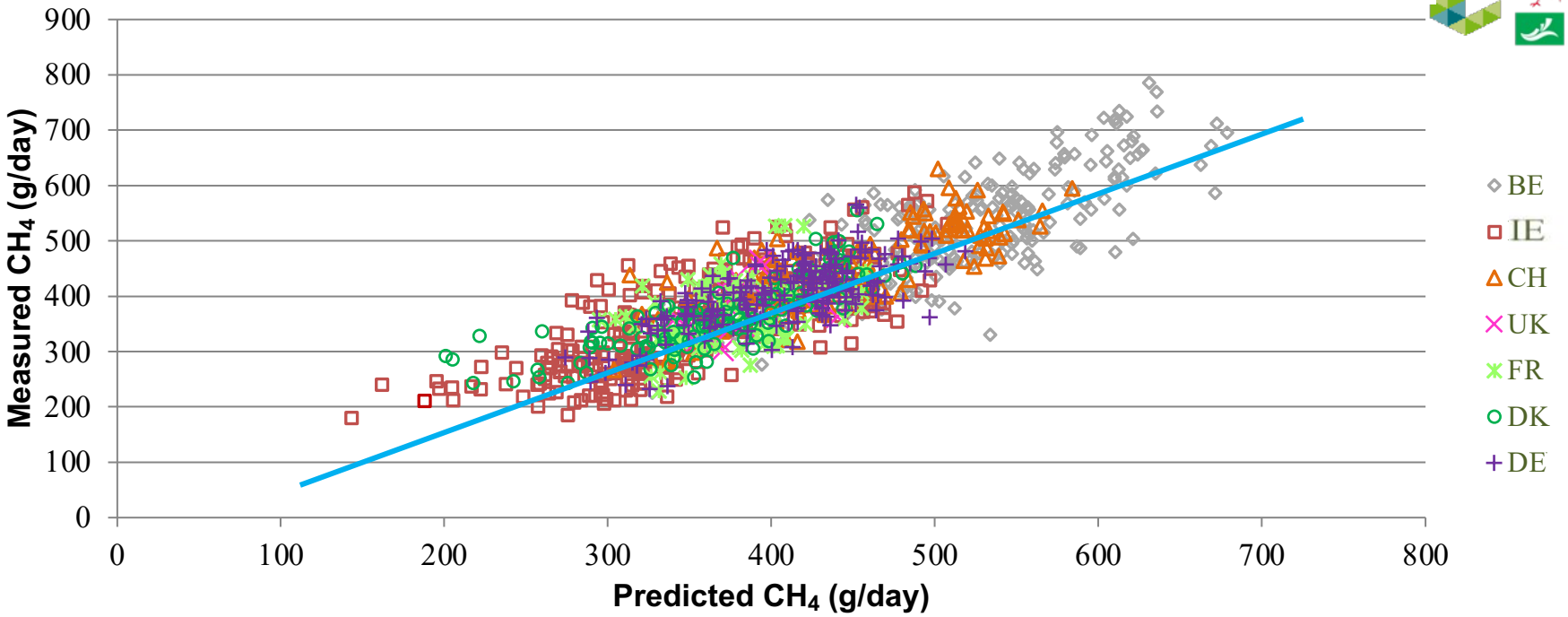
- Common traits
  - CH_4 production (g/day per cow)
  - CH_4 yield (g/kg intake) ➔ intake = DMI
  - CH_4 intensity (g/kg output) ➔ output = combination of Milk, F%, P%

    (can be Milk or FPM or FPCM or ECM)

- Other recently developed traits
  - "Residual CH_4" = CH_4 prod. – $E_{phen\ or\ gen}$ [CH_4 |(milk prod. + maintenance)]
  - "CH_4 Efficiency" = CH_4 prod. – E_{gen}[CH_4 |(milk, fat and protein yields)]

↑ Canadian Trait
(https://lactanet.ca/en/introducing-methane-efficiency/)

Used MIR Equation

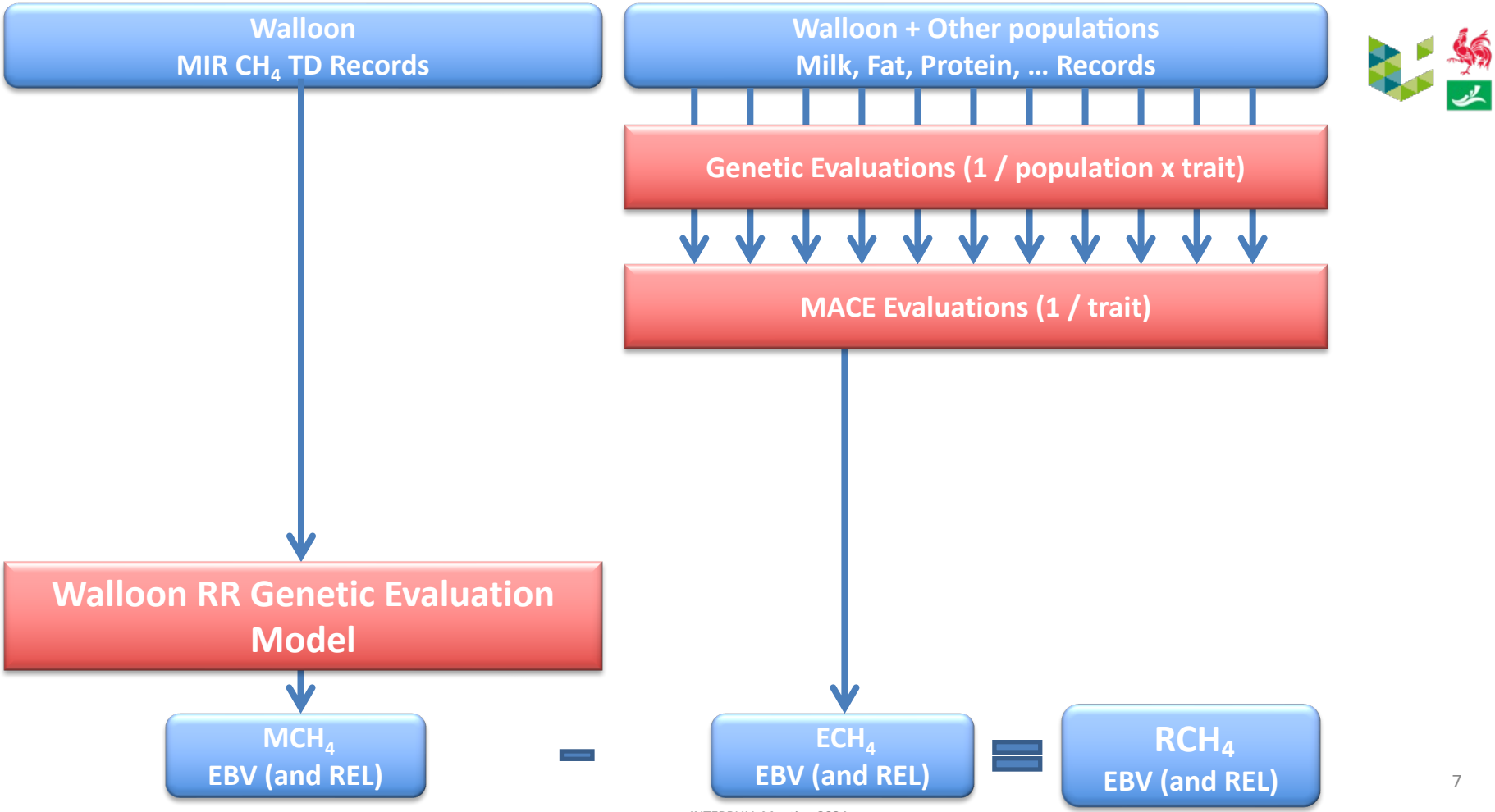


CH_4 Ref. method	n data	n cows	Origin	R^2c	SEC (g/d)	R^2cv	SECV (g/d)
SF_6 & RC	1,089	299	BE, IE, CH, UK, FR, DK, DE	0.73	53	0.68	57

Ongoing: Test Computations ← Walloon Data

	Lactation			
	1	2	3	All (1-3)
TD CH_4 records	1 935 284	1 528 675	1 081 440	4 545 399
Cows	287 511	226 132	161 234	328 290
Mean CH_4 (g/day)	323	354	367	344
SD CH_4 (g/day)	68	70	72	72

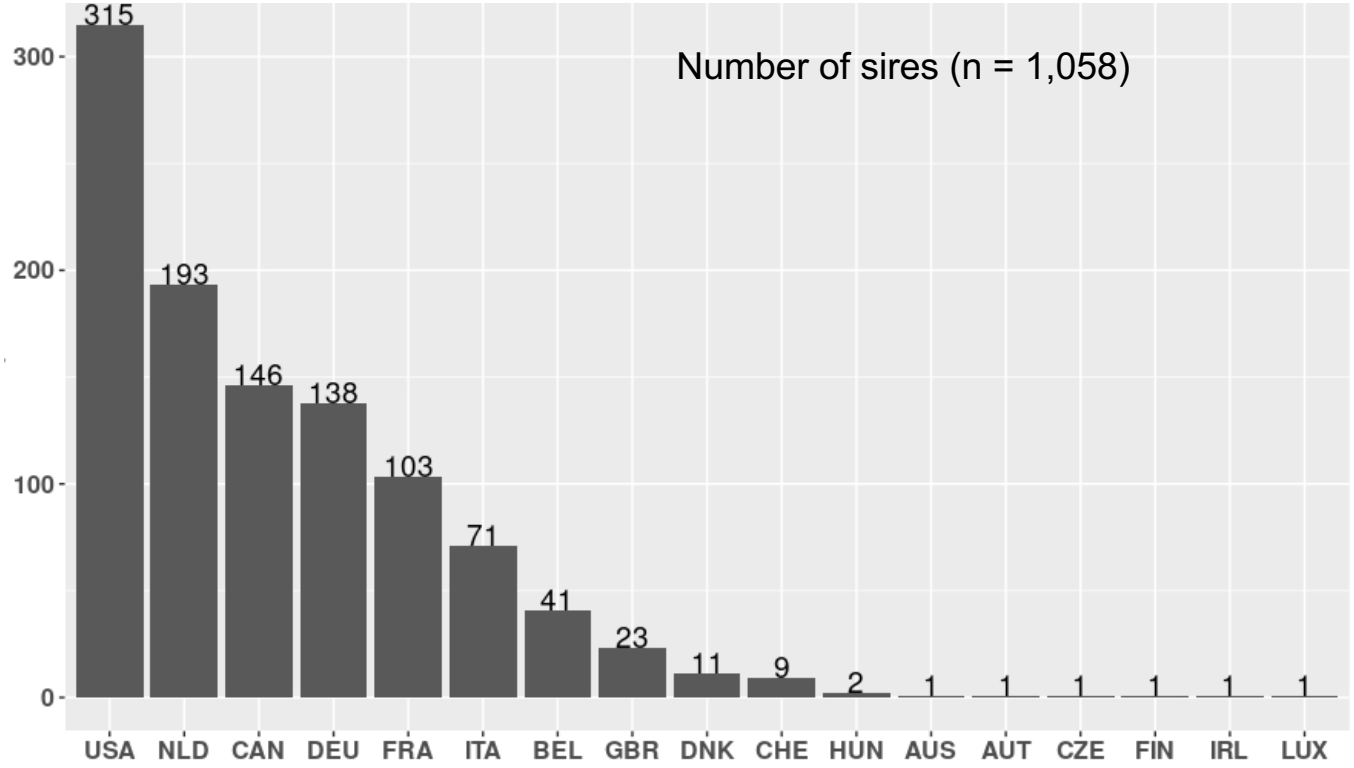
+ 18 467 genotypes for Holsteins (not yet used)


Walloon
MIR CH_4 TD Records
Walloon + Other populations
Milk, Fat, Protein, … Records
Genetic Evaluations (1 / population x trait)
MACE Evaluations (1 / trait)
Walloon RR Genetic Evaluation Model
MCH_4
EBV (and REL)
ECH_4
EBV (and REL)
RCH_4
EBV (and REL)

First results…

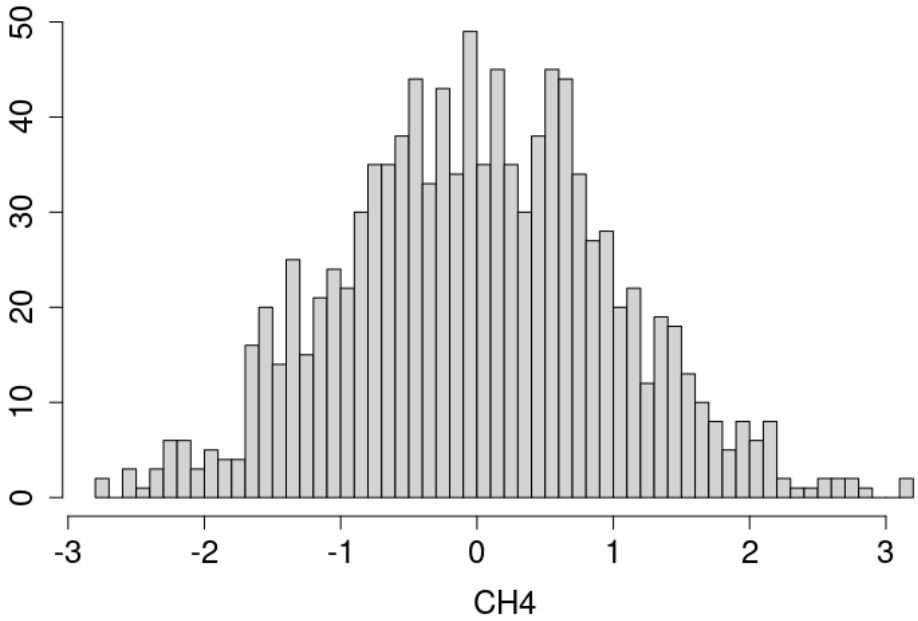
Evaluated International Sires for CH_4 / RCH_4

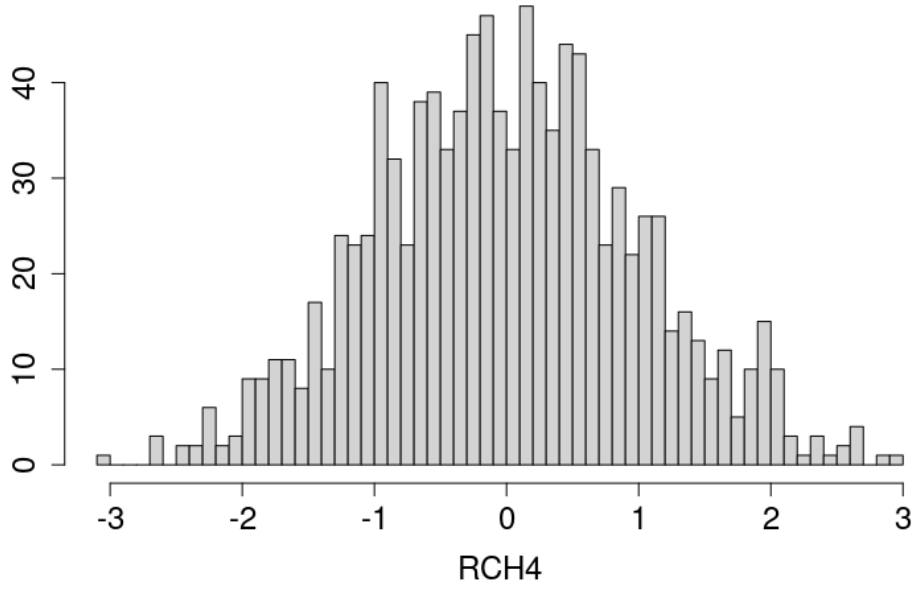
(30 daug. with records + EBV for MACE/GMACE available + REL CH_4 min 0.50)



Distribution of REBV for CH_4 and RCH_4

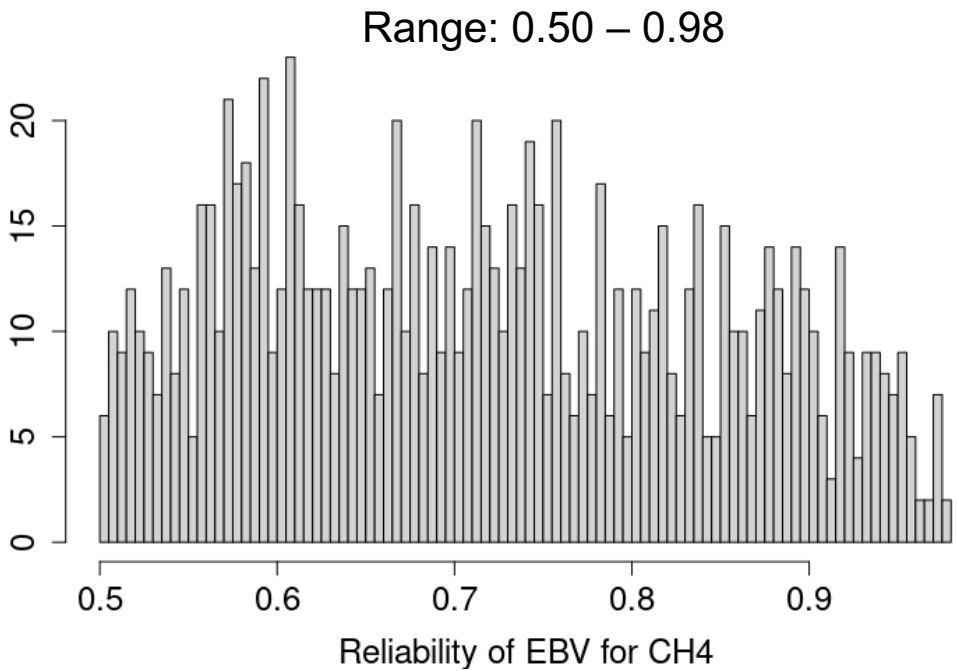
(same n = 1,058 sires)

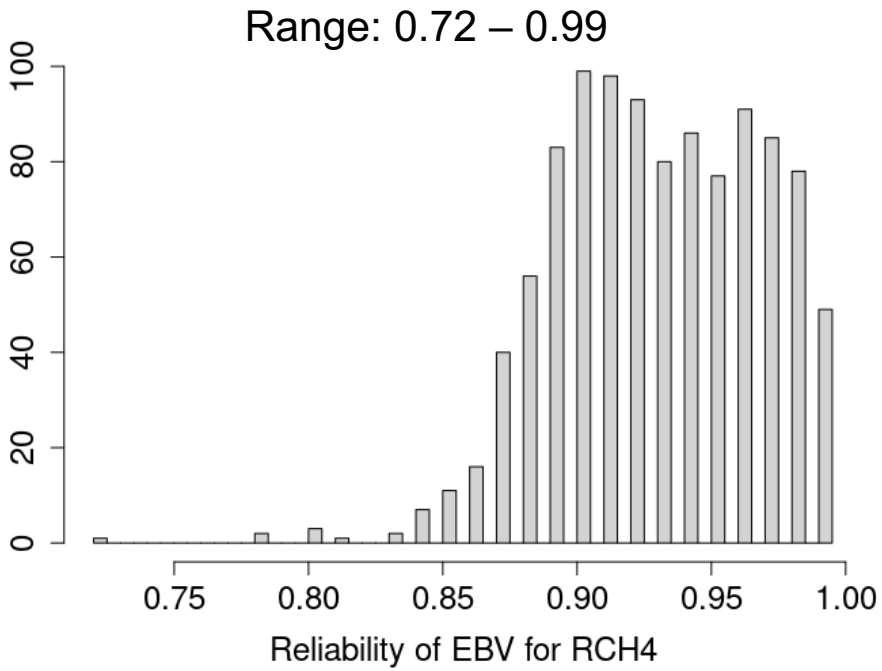




Distribution of Reliability for CH_4 and RCH_4

(n = 1,058 sires)





Pearson Correlations Among 5 Traits

(based on EBV of same n = 1,058 sires)

	CH_4	RCH_4	MY	FY	PY
CH_4	1.00	0.85	0.16	0.51	0.33
RCH_4		1.00	0.00	0.00	0.00
MY			1.00	0.49	0.81
FY				1.00	0.71
PY					1.00

Updates on the link between CH_4 / RCH_4 and other evaluated traits…

Trait	CH_4	RCH_4	Index	CH_4	RCH_4
Udder health	0.35	0.30	V€L(Production)	0.50	0.01
Longevity	0.45	0.33	V€M(Feet&Legs)	0.21	0.16
Fertility	0.20	0.25	V€C(Body)	0.09	0.08
Direct CE	0.36	0.20	V€P(Udder)	0.33	0.35
Maternal CE	0.19	0.08	V€T(Conformation)	0.34	0.33
Stature	0.16	0.17	V€F(Functional traits)	0.45	0.34
Angularity	0.16	0.15	V€G(Global index)	0.61	0.25

Trait	CH_4	RCH_4	Index	CH_4	RCH_4
Udder health	0.35	0.30	$V€L_{(Production)}$	0.50	0.01
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Outstanding issues and future developments…

Remaining problem: Defining ECH_4

- Our results, confirm other earlier results:

CSIRO PUBLISHING

Animal Production Science, 2018, **58**, 1779–1787
http://dx.doi.org/10.1071/AN16592

Consequences of genetic selection for environmental impact traits on economically important traits in dairy cows

Purna Kandel[A], *Sylvie Vanderick*[A], *Marie-Laure Vanrobays*[A], *Hélène Soyeurt*[A] *and Nicolas Gengler*[A,B]

- But there is far from any consensus on these correlations!

Remaining problem: Defining ECH_4

- Our results, confirm other earlier results:

CH_4 ↘ ≫ Economic results ↘

- Therefore, if we want to do reasonable breeding should we not define "CH_4 efficiency" at a constant economic level?
- In our context need to compare to expected CH_4 at a given V€G!
- Selection index to the rescue 😉!

"CH_4 Economic Efficiency" based on CH_4 production – $E_{gen}[CH_4 \mid V€G]$

Practical Implementation Steps

- Integration in our (new) ssGBLUP workflow
  - Reminder: currently (since 2015):
    - "Approximate" Bayesian ssGBLUP system
      ➔ regenerating ssGBLUP-MME from EBV and REL
  - New (starting 2024-2025):
    - (Except type) all evaluations ➔ "full" ssGBLUP
    - External information (i.e., MACE EBV) introduced into systems
      - Through pseudo-records (DRP and ERC) and pseudo-traits
      - Avoiding double counting….
- Extension to Dual-Purpose Blue Cattle ➔ MIR-CH_4 equation!

International Collaborations…

- Constantly improving MIR-CH_4 prediction equation
  - Incoming GreenFeed data through several collaborations
  - Other breeds ➔ dual-purpose
- Exchange of SNP CH_4 effects with other countries
  - Integration into ssGBLUP equation system
- INTERBULL…

Acknowledgements

- Support of the Futurospectre partnership
  - Awé groupe – Comité du Lait – CRA-W – ULiège-GxABT
- CECI Consortium for computational resources
- Service Public de Wallonie
- National Fund for Scientific Research
- Support by different European Projects
- Many international partners….

Thank you for your attention

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