

Walloon single step genomic evaluation system integrating local and MACE EBV

F.G. Colinet¹, J. Vandenplas^{1,2}, P. Faux¹, S. Vanderick¹,
R. Renaville¹, C. Bertozzi³, H. Hubin³, and N. Gengler¹

¹ University of Liège, Gembloux Agro-Bio Tech, Belgium
² National Fund for Scientific Research, Belgium
³ Walloon Breeding Association, Belgium

30th Annual Meeting of INTERBULL, Nantes, France, August 23rd – 25th 2013

Context

- Walloon dairy cattle:
 - Small scale population
 - Foreign AI sires of:
 - ❖ 87% of cows in 1st to 3rd lactation in 2012, of which:
 - ✓ 25% sired by 371 bulls born in USA
 - ✓ 16% sired by 298 bulls born in NLD
 - ✓ 16% sired by 110 bulls born in FRA
 - ✓ 15% sired by 240 bulls born in DEU
 - ✓ 12% sired by 177 bulls born in CAN
 - ✓ 16% sired by bulls born in other countries
- Most reliable GEBV if estimated from all available sources

30th Annual Meeting of INTERBULL, Nantes, France, August 23rd – 25th 2013

Context

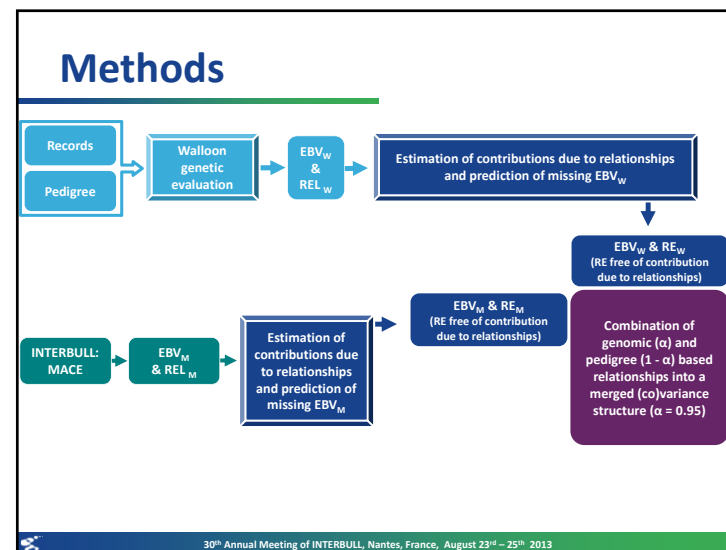
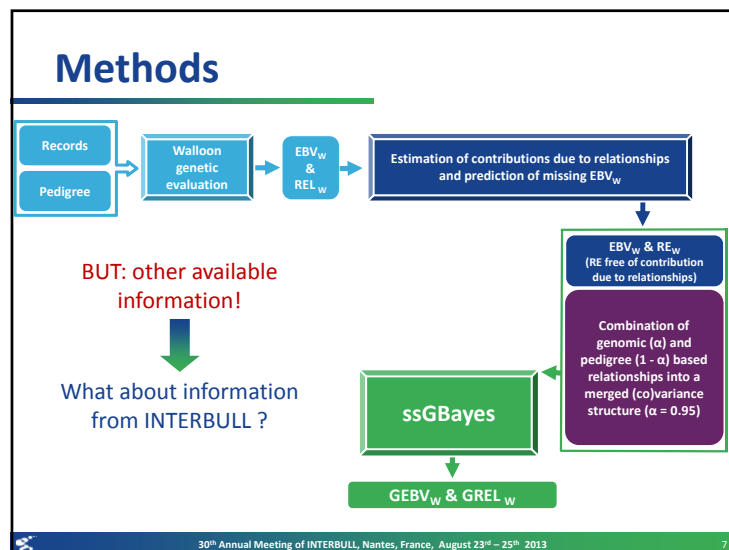
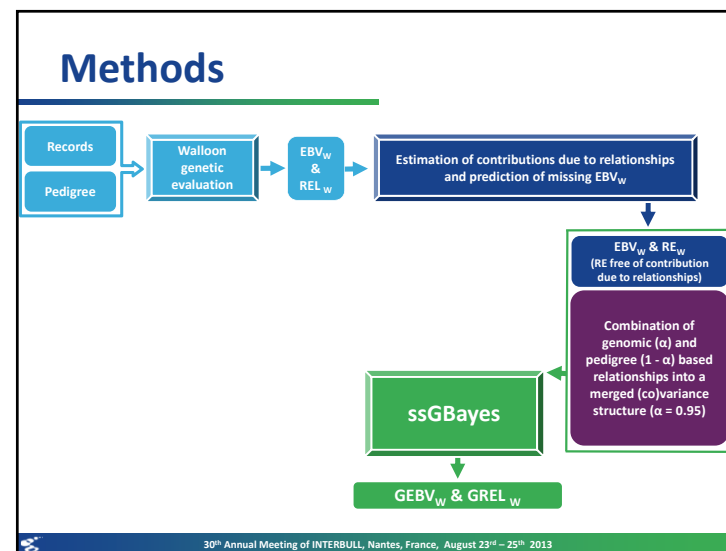
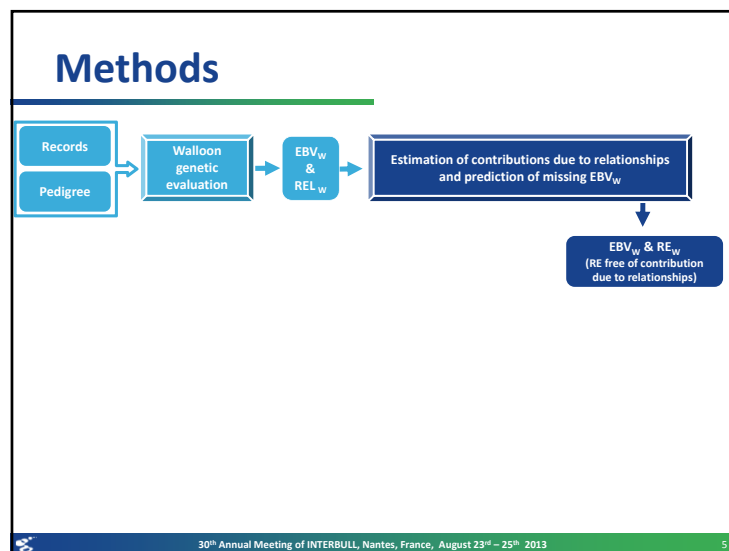
- Single-step genomic evaluation (ssGBLUP):
 - Simultaneous combination of genomic, pedigree and phenotypic information
- Current limitation
 - Only available local records used
 - External phenotypic information (e.g., available as MACE EBV) not used

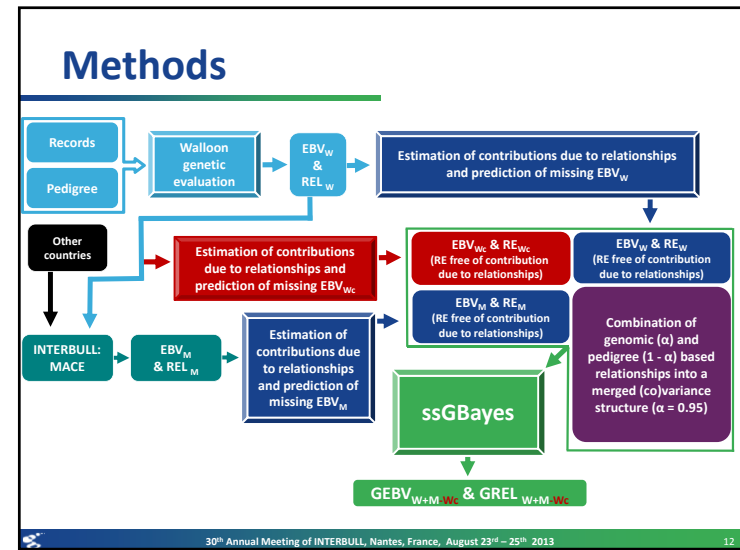
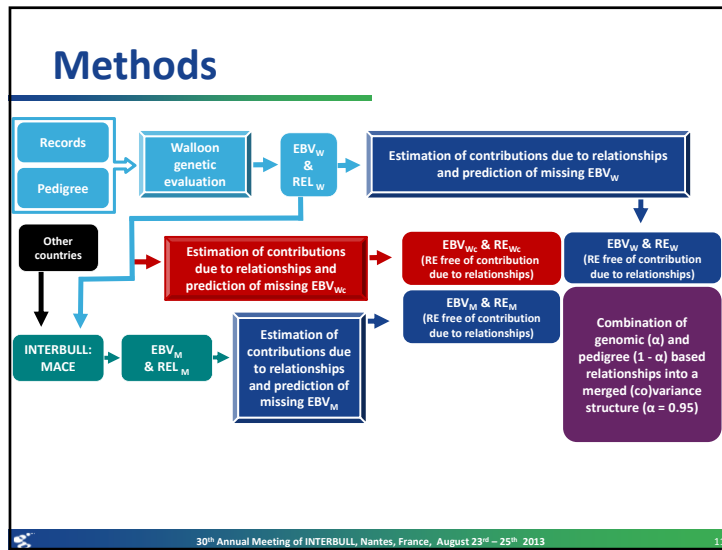
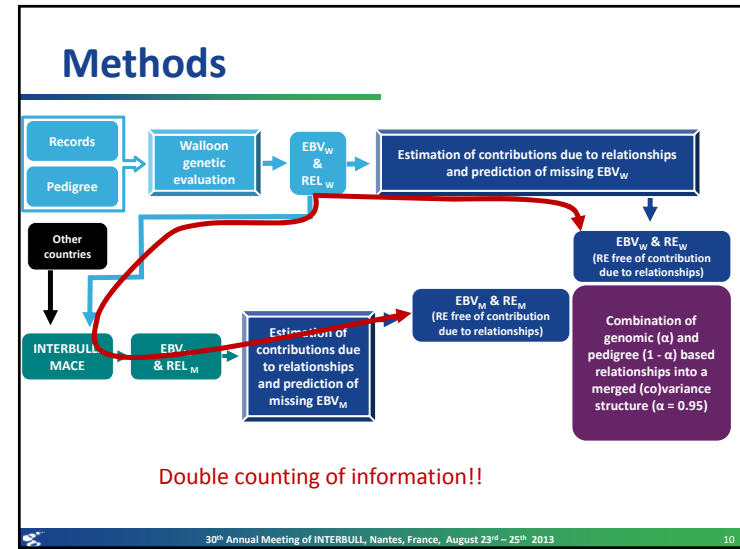
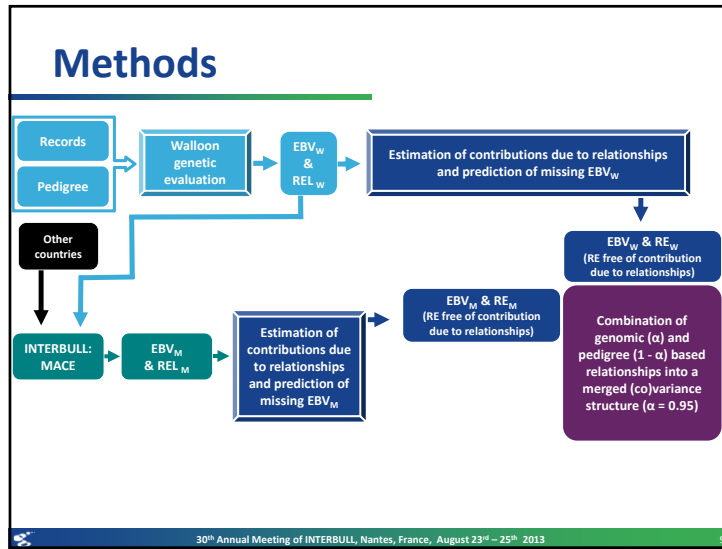
30th Annual Meeting of INTERBULL, Nantes, France, August 23rd – 25th 2013

Aim

- To develop a genomic evaluation adapted to Walloon dairy cattle
 - ➔ Needs to combine simultaneously:
 - Genotypes
 - Pedigree
 - Local information
 - Foreign information
 - Local and foreign information:
 - Considered as *a priori* known external information
 - Incorporated using a Bayesian approach
 - Correct propagation of all this information without multiple considerations of contributions due to relationships and due to records
 - Miming hypothetical mixed model equations and replacing pedigree information by combined pedigree and genomic information ➔ Bayesian single step Genomic Evaluation: **ssGBayes**

30th Annual Meeting of INTERBULL, Nantes, France, August 23rd – 25th 2013





Methods

- Combination of genotype, pedigree, local and foreign information
→ **ssGBayes**

$$(H^{-1} + \Lambda_W + \Lambda_M - \Lambda_{Wc})\hat{a} = D_W^{-1}\hat{u}_W + D_M^{-1}\hat{u}_M - D_{Wc}^{-1}\hat{u}_{Wc}$$

- H: Combined genomic (α) and pedigree ($1 - \alpha$) based relationships into a merged (co)variance structure ($\alpha = 0.95$)
- \hat{a} : $GEBV_{W+M-Wc}$
- \hat{u}_W, \hat{u}_M and \hat{u}_{Wc} : Available and predicted EBV_W, EBV_M and EBV_{Wc}
- D_W, D_M and D_{Wc} : Prediction error (co)variance matrix of \hat{u}_W, \hat{u}_M and \hat{u}_{Wc}

30th Annual Meeting of INTERBULL, Nantes, France, August 23rd – 25th 2013 13

Methods

- Combination of genotype, pedigree, local and foreign information
→ **ssGBayes**

$$(H^{-1} + \Lambda_W + \Lambda_M - \Lambda_{Wc})\hat{a} = D_W^{-1}\hat{u}_W + D_M^{-1}\hat{u}_M - D_{Wc}^{-1}\hat{u}_{Wc}$$

Least square part of LHS of hypothetical BLUP of Walloon information

Least square part of LHS of hypothetical BLUP of foreign information free of Walloon information

RHS of hypothetical BLUP of Walloon information

RHS of hypothetical BLUP of foreign information free of Walloon information

→ For more information about the theory behind this equation, see presentation of *Vandenplas et al.* at EAAP meeting, session 34, Wednesday 28th PM

30th Annual Meeting of INTERBULL, Nantes, France, August 23rd – 25th 2013 14

Data

- 1,903 genotyped animals
 - 1,378 bulls and 525 cows
 - 38,604 SNP after editing
- 6-generations extracted pedigree: 16,234 animals
- Traits: milk, fat and protein yields, SCS, longevity, stature and udder support
- Walloon EBV (EBV_W)
- MACE EBV (EBV_M)
- Bulls with Walloon EBV contributing to MACE (EBV_{Wc})

30th Annual Meeting of INTERBULL, Nantes, France, August 23rd – 25th 2013 15

Data

- 1,903 genotyped animals
 - 1,378 bulls and 525 cows
 - 38,604 SNP after editing
- 6-generations extracted pedigree: 16,234 animals
- Traits: milk, fat and protein yields, SCS, longevity, stature and udder support *e.g.:* MILK
- Walloon EBV (EBV_W) 12,046
- MACE EBV (EBV_M) 1,981
- Bulls with Walloon EBV contributing to MACE (EBV_{Wc}) 601
- Reliabilities (REL) for all GEBV obtained through inversion of left-hand side

30th Annual Meeting of INTERBULL, Nantes, France, August 23rd – 25th 2013 16

Results: Milk yield

□ Average REL (SD) associated to EBV_{W^p} , $GEBV_{W^g}$ and $GEBV_{W+M-Wc}$ for genotyped bulls

Class of REL_{W^g}	N	$EBV_{W^p}^1$	$GEBV_{W^g}^2$
< 0.50	647	0.25 (0.12)	0.44 (0.09)

¹ REL obtained from Walloon polygenic evaluation
² REL obtained from Walloon genomic evaluation using only EBV_{W^g}

30th Annual Meeting of INTERBULL, Nantes, France, August 23rd – 25th 2013 17

Results: Milk yield

□ Average REL (SD) associated to EBV_{W^p} , $GEBV_{W^g}$ and $GEBV_{W+M-Wc}$ for genotyped bulls

Class of REL_{W^g}	N	$EBV_{W^p}^1$	$GEBV_{W^g}^2$	$GEBV_{W+M-Wc}^3$
< 0.50	647	0.25 (0.12)	0.44 (0.09)	0.80 (0.09)

¹ REL obtained from Walloon polygenic evaluation
² REL obtained from Walloon genomic evaluation using only EBV_{W^g}
³ REL obtained from Walloon genomic evaluation using EBV_{W^p} , EBV_M and EBV_{Wc}

30th Annual Meeting of INTERBULL, Nantes, France, August 23rd – 25th 2013 18

Results: Milk yield

□ Average REL (SD) associated to EBV_{W^p} , $GEBV_{W^g}$ and $GEBV_{W+M-Wc}$ for genotyped bulls

Class of REL_{W^g}	N	$EBV_{W^p}^1$	$GEBV_{W^g}^2$	No. of publishable GEBV	$GEBV_{W+M-Wc}^3$	No. of publishable GEBV
< 0.50	647	0.25 (0.12)	0.44 (0.09)	194	0.80 (0.09)	628

¹ REL obtained from Walloon polygenic evaluation
² REL obtained from Walloon genomic evaluation using only EBV_{W^g}
³ REL obtained from Walloon genomic evaluation using EBV_{W^p} , EBV_M and EBV_{Wc}

30th Annual Meeting of INTERBULL, Nantes, France, August 23rd – 25th 2013 19

Results: Milk yield

□ Average REL (SD) associated to EBV_{W^p} , $GEBV_{W^g}$ and $GEBV_{W+M-Wc}$ for genotyped bulls

Class of REL_{W^g}	N	$EBV_{W^p}^1$	$GEBV_{W^g}^2$	No. of publishable GEBV	$GEBV_{W+M-Wc}^3$	No. of publishable GEBV
< 0.50	647	0.25 (0.12)	0.44 (0.09)	194	0.80 (0.09)	628
0.50 – 0.74	173	0.63 (0.07)	0.69 (0.06)	173	0.87 (0.05)	173

¹ REL obtained from Walloon polygenic evaluation
² REL obtained from Walloon genomic evaluation using only EBV_{W^g}
³ REL obtained from Walloon genomic evaluation using EBV_{W^p} , EBV_M and EBV_{Wc}

30th Annual Meeting of INTERBULL, Nantes, France, August 23rd – 25th 2013 20

Results: Milk yield

□ Average REL (SD) associated to EBV_{W^1} , $GEBV_{W^2}$ and $GEBV_{W+M-Wc^3}$ for genotyped bulls

Class of REL_{W^1}	N	EBV_{W^1}	$GEBV_{W^2}$	No. of publishable GEBV	$GEBV_{W+M-Wc^3}$	No. of publishable GEBV
< 0.50	647	0.25 (0.12)	0.44 (0.09)	194	0.80 (0.09)	628
0.50 – 0.74	173	0.63 (0.07)	0.69 (0.06)	173	0.87 (0.05)	173
≥ 0.75	390	0.90 (0.07)	0.91 (0.06)	390	0.94 (0.04)	390

¹ REL obtained from Walloon polygenic evaluation
² REL obtained from Walloon genomic evaluation using only EBV_{W^1}
³ REL obtained from Walloon genomic evaluation using EBV_{W^1} , EBV_M and EBV_{Wc}

30th Annual Meeting of INTERBULL, Nantes, France, August 23rd – 25th 2013 21

Results: All traits

□ Average REL (SD) associated to EBV_{W^1} , $GEBV_{W^2}$ and $GEBV_{W+M-Wc^3}$ for genotyped bulls

Traits	N	$REL_{W^1} < 0.50$		
		EBV_{W^1}	$GEBV_{W^2}$	$GEBV_{W+M-Wc^3}$
Milk yield	647	0.25 (0.12)	0.44 (0.09)	0.80 (0.09)
Fat yield	642	0.26 (0.12)	0.45 (0.09)	0.80 (0.09)
Protein yield	644	0.26 (0.12)	0.44 (0.09)	0.80 (0.09)
SCS	682	0.25 (0.12)	0.43 (0.09)	0.84 (0.12)
Longevity	889	0.23 (0.12)	0.36 (0.09)	0.51 (0.09)
Stature	632	0.28 (0.10)	0.46 (0.08)	0.82 (0.13)
Udder support	699	0.28 (0.10)	0.43 (0.08)	0.71 (0.14)

¹ REL obtained from Walloon polygenic evaluation
² REL obtained from Walloon genomic evaluation using only EBV_{W^1}
³ REL obtained from Walloon genomic evaluation using EBV_{W^1} , EBV_M and EBV_{Wc}

30th Annual Meeting of INTERBULL, Nantes, France, August 23rd – 25th 2013 22

Results: Milk yield

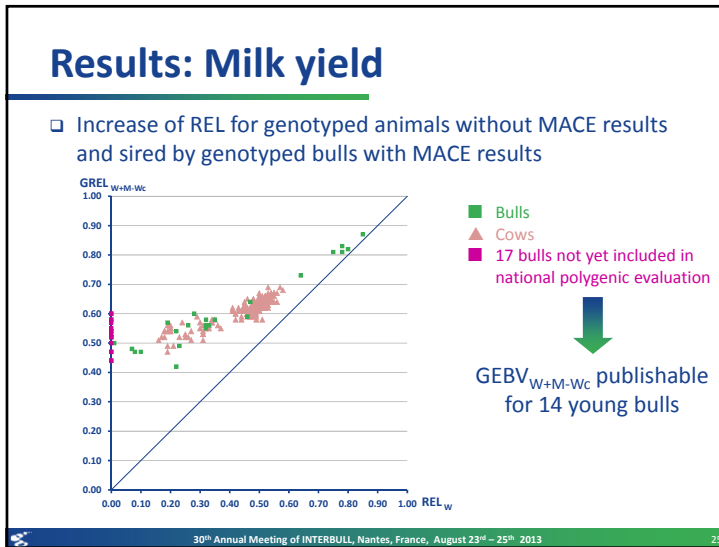
□ Increase of REL for genotyped animals without MACE results and sired by genotyped bulls with MACE results

30th Annual Meeting of INTERBULL, Nantes, France, August 23rd – 25th 2013 23

Results: Milk yield

□ Increase of REL for genotyped animals without MACE results and sired by genotyped bulls with MACE results

30th Annual Meeting of INTERBULL, Nantes, France, August 23rd – 25th 2013 24



Results: All traits

- Average REL (SD) associated to GEBV_{W+M-Wc} for genotyped bulls without MACE result and sired by genotyped bulls with MACE result

Traits	0.01 ≤ REL _w ≤ 0.24		
	N	GEBV _{W+M-Wc} ¹	No. of publishable GEBV
Milk yield	8	0.49 (0.05)	3
Fat yield	8	0.49 (0.05)	4
Protein yield	8	0.49 (0.05)	3
SCS	9	0.52 (0.05)	8
Longevity	14	0.37 (0.06)	8
Stature	21	0.51 (0.04)	14
Udder support	21	0.46 (0.05)	14

¹ REL obtained from Walloon genomic evaluation using EBV_w, EBV_M and EBV_{wc}

30th Annual Meeting of INTERBULL, Nantes, France, August 23rd – 25th 2013 26

Results: All traits

- Average REL (SD) associated to GEBV_{W+M-Wc} for genotyped bulls without MACE result, **not yet included in national polygenic evaluation** and sired by genotyped bulls with MACE result

Traits	Missing REL _w → new young bulls		
	N	GEBV _{W+M-Wc} ¹	No. of publishable GEBV
Milk yield	17	0.53 (0.05)	13
Fat yield	17	0.53 (0.06)	13
Protein yield	17	0.53 (0.05)	13
SCS	20	0.54 (0.05)	19
Longevity	23	0.38 (0.05)	18
Stature	21	0.54 (0.06)	15
Udder support	21	0.47 (0.07)	15

¹ REL obtained from Walloon genomic evaluation using EBV_w, EBV_M and EBV_{wc}

30th Annual Meeting of INTERBULL, Nantes, France, August 23rd – 25th 2013 27

- ### Conclusion
- Bayesian approach integrates well MACE results into ssBLUP
 - ➔ Recovers indirectly large amount of phenotypic information
 - Correct propagation of all available information
 - Double counting of contributions due to relationships and own records avoided
 - More accurate prediction for genotyped animals
 - Increase of publishable GEBV number
- 30th Annual Meeting of INTERBULL, Nantes, France, August 23rd – 25th 2013 28

Thank you for your attention



Wallonie




DGO3



WBI



fnrs



ali



Fonds National de la Recherche Luxembourg

- Acknowledgments for financial support
 - Service Public de Wallonie (SPW – DGO3, Belgium) through project D31-1274 **DairySNP**
 - National Fund for Scientific Research and Wallonie Brussels International for scientific stays
 - Fonds National de la Recherche Luxembourg (FNR)
- Acknowledgments
 - CECI for computational resources
 - Animal and Dairy Science Department, University of Georgia, Athens, USA
 - Animal Science Department, University of Ljubljana, Slovenia

Corresponding author's e-mail: Frederic.Colinet@ulg.ac.be



30th Annual Meeting of INTERBULL, Nantes, France, August 23rd – 25th 2013