Analysis of the Pilot SGMACE: French Report

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Abstract

In February 2011, Interbull ran a SGMACE and a MACE including only country that provided GEBVs. We compared the SGMACE results with the MACE results and with the french domestic GEBVs. We analysed protein yield, somatic cell score (SCS), stature and fertility (CC1) only for bulls having genomic information. The study showed expected results such as high correlations, increased reliabilities and no mean difference between MACE and SGMACE proofs, excepted in few cases. However, the variability of SGMACE-GEBVs for stature and SCS highly decreased compared to EBVs, which was not explained and which may suggest differences between domestic GEBVs and EBVs.

The study also showed the impact of genetic correlations between countries on SGMACE results. They affect the gain in accuracy between MACE and SGMACE; when they are available, French domestic GEBVs of foreign bulls are more reliable than SGMACE GEBVs, which also affected the variability of GEBVs.

At this stage, the benefit in SGMACE seems limited and more investigation is needed: closer analysis of consistency between EBVs and GEBVs sent by each country, analysis with all GEBVs (official and unofficial), and a new SGMACE pilot run may answer some questions.

Introduction

In February 2011, Interbull delivered the results of the first pilot Single G-MACE (Van Raden and Sullivan, 2009; Sullivan, 2011).

The aim of this study was to compare these results with those obtained with the French domestic genomic evaluation and with the conventional MACE, and to assess the impact of genetic correlations between countries on international SGMACE GEBVs and their accuracy.

Data used in this study and description of international GEBVs computed with GMACE

Three sets of results were available for this study:

- SGMACE results (called SGMACE – GEBV hereafter): Interbull ran two evaluations, one (gr) with only countries having provided GEBVs, the other (ga) with all the countries participating to the routine MACE. For the present study, we only considered the first run (gr).
- MACE results expressed in French units (called MACE EBV): Interbull run two evaluations, one (cr) with only countries having provided GEBVs, the other (ca) with all the countries. As for SGMACE results, we only considered the first run (cr). The progeny information used for MACE and GMACE is exactly the same.
- French GEBVs sent to Interbull for the pilot run. For bulls having more than 150 French daughters in lactation, polygenic information used in French domestic GEBVs was based on the French DYD of bulls. For bulls having foreign daughters and less than 150 French daughters in lactation, it was based on deregressed Interbull EBVs. This means that the progeny information may not be the same for French GEBV and for MACE/SGMACE, but only when bulls have a large number of French daughters. Thus, it should not affect the comparisons of results expressed in French units.

For a bull with a GEBV in France and in another country, SGMACE may account either for the French GEBV, or for the other GEBV. The selection criteria were described by Zumbach *et al.* (2011).

For this study, four traits were analyzed: Protein Yield, Stature, Somatic Cell Score (SCS) and fertility (cow's ability to conceive, CC1). We only considered bulls with genomic information ("gbull" list sent by Interbull).

Table 1 gives the number of bulls for each trait, according to the country of national GEBV and the total number of daughters. There were very few bulls with no daughters, which may be explained by the fact that their national GEBVs were not official (in this case proofs of young bulls were taken into account by Interbull but not returned to the users). Other bulls may be missing, such as candidates not selected for AI. Since this pilot run, Interbull clarified its recommendations and asked each country to send all the GEBVs, whatever the final status of bull, in order to avoid bias due to pre-selection.
Figure 1 shows the impact of genetic correlations on average reliabilities: the lower the genetic correlation, the poorer the reliability, particularly for bulls without daughters. On Fertility, the average reliability of Dutch and German bulls without daughters is 32 and 35% only, which should be compared to the average reliability of French bulls (68%). Even reliabilities of SGMACE - GEBVs on Protein were still sensitive to the genetic correlations: average reliabilities of French bulls without any daughter was 73.6%, instead of 60.8% for German bulls ($rg_{FRA\text{-}DEU} = 0.85$) and 44.3% for NZL bulls ($rg_{FRA\text{-}NZL} = 0.75$).

Comparison of SGMACE and MACE results

MACE and SGMACE results were compared first, according to the country of origin of GEBV and the total number of daughters (table 2). Only categories with more than 20 bulls are reported in the tables.

For Stature, SCS and Fertility, we observed a high correlation between proofs (particularly for bulls with a large number of daughters). There was no mean difference (except for Stature for New Zealand), and an increase in reliability, due to the genomic information. As expected, the increase in reliability was higher for bulls with a low number of daughters. Moreover, the comparison of Stature, SCS and Fertility shows the impact of genetic correlations and heritability on the gain in accuracy: the highest increase is observed on SCS, which is a trait with a moderate heritability, but with high genetic correlations.
For Protein, the averages are different in some cases, particularly for French and US bulls with less than 50 daughters (average decrease of 1.93 and 2.55 kg respectively), or for bulls with GEBVs in New Zealand or Poland (average increase of 1.90 and 2.37 kg respectively). Moreover, even though the reliability did increase as expected, the variability of GMACE results was lower than for MACE. The average decrease in SGMACE GEBV of French bulls with few daughters may be related to the fact that the French genomic evaluation excludes performances of bulls' dams, in order to reduce the impact of preferential treatments on dams on the GEBVs of their sons. Thus, the domestic GEBVs used for Interbull SGMACE are lower on average and slightly less variable than the EBVs of the same bulls: the mean difference between GEBVs and EBVs of bulls with less than 50 daughters was -1.8 kg Protein, with a decrease in variability of -2.44%, which is consistent with the previous observations. However, it does not explain the changes in averages of bulls from the other countries.

The variability of SGMACE-GEBVs for Stature and SCS decreased in many cases, which was not expected considering the increase in reliability. This is particularly the case for New Zealand and Poland on Stature. The explanation is different from the case of Protein, since the standard deviation does not decrease for France. To have a better understanding, domestic GEBVs and EBVs should be compared in each country.

Comparison of SGMACE and French GEBVs

French domestic GEBVs were compared to SGMACE results expressed in French units, according to the country of origin of the GEBV chosen by Interbull (table 4).

For Protein Yield, Stature and SCS, correlations between French GEBVs and SGMACE results are high, whatever the country is, except in some cases for bulls without any daughter. For Fertility, the correlation is much lower, particularly when the domestic GEBV considered by Interbull was Dutch. The correlation is not much higher than if it had been obtained from two independent sets of evaluations (in this case the correlation could be assessed from the square root of product of reliabilities), even when the number of daughters is high.

Here also, the impact of genetic correlations on SGMACE- GEBVs can be observed: the reliabilities and the GEBV variability of bulls whose domestic GEBV was not the French one are much lower than those obtained with the French GEBVs, particularly when genetic correlations are moderate (protein yield) or low (fertility). For Protein and for Fertility, this still affects SGMACE results, even when bulls had a large number of daughters.

Discussion and Conclusion

First, some results of this study need more investigation: the low correlation between French domestic GEBVs and SGMACE GEBV for fertility may indicate a problem of consistency of GEDCs. Differences between MACE and GMACE results must be better understood. At this stage we recommend an analysis including every genotyped animals (official and unofficial) and a close comparison of GEBVs and EBVs sent by each country before merging both types of data. A new pilot SGMACE was undertaken, and many questions related to GEDCs, population to be sent etc… are expected to be solved.

Moreover, this study clearly shows the impact of genetic correlations on SGMACE results: the weaker the correlations, the lower the reliabilities. Genetic correlations also affect the variability of SGMACE GEBVs, which will probably have a big impact on the rankings of bulls. The impact of genetic correlations can be seen, even with moderate genetic correlations, such as for Protein Yield.

As long as no genomic evaluations were available, MACE was the best way to compare bulls worldwide, because countries had no way to estimate a breeding value of a foreign bull on their own scale if this bull had no daughters in their country. Now, with genomic evaluations, we may have other alternatives: an exporting country may send genotypes of its best bulls to other national centers in order to have them evaluated in each country. In this case the obtained GEBV will be enhanced by genomic information which is not regressed by the genetic correlation, and reliability will be higher than with GMACE.

Finally GMACE does not help countries in developing their own genomic evaluation: to do that, Interbull needs the genotypes of the whole reference population of each country, which is not envisioned in the short term but which would be the only way to solve both problems of low genetic correlations and of small populations. Nevertheless, all countries should be aware of the fact that when we start with genomic evaluations of new traits, all countries, even the big ones, will have a small reference population since most of their bulls will have no progeny with performances, and they would benefit from a common genomic evaluation.

In conclusion, there is a strong risk of a limited benefit of SGMACE, when compared to the huge amount of work that is demanded for its development. For two years now, the Interbull community has been concentrated on genomics. This should not lead us to forgive the crucial role played by Interbull on polygenic evaluations: most countries, even in the era of genomics, will use MACE EBVs in order to increase their reference population using foreign results. In this area, there are many challenges that must not be forgotten and that may become even more strategic in the near future. SD-MACE and MT-MACE are still waited ; the implementation of a method robust to biases due to pre-selection is urgent (Patry et al, this meeting); and countries will develop evaluations on new traits, which will bring new questions...

Thus, improvements on MACE must not be considered as “old fashioned”, but as strategic for all our activities.

References

Patry, C., Jorjani, H. & Ducrocq, V. 2011. Implementation of genomic selection at national level: impact of preselection and biased national BLUP evaluations on international genetic evaluations. *Interbull Bulletin 44,* 67-73.

Sullivan, P.G. 2011. Accounting for residual correlations among regional genomic predictions via GMACE. Interbull Workshop, February 27-28 2011, Guelph, Canada. *Interbull Bulletin 43,* 19-24.

Sullivan, P.G. & Van Raden, P.M. 2010. GMACE implementation. *Interbull Bulletin 41,* 3-7.

Zumbach, B., Jakobsen, J., Jorjani, H. & Dürr, J. 2011. Data Selection and Pilot Run on Simplified Genomic MACE (SGMACE). Interbull Workshop, February 27-28 2011, Guelph, Canada. *Interbull Bulletin 43,* 11-18.

Table 1. Number of bulls with French EBVs and GEBVs.

		Protein	SCS	Stature	CC1
DEU		9666	9467	9382	9440
	> 200 daughters	1380	1354	625	1086
	101 - 200 daughters	2788	2721	434	1391
	51 - 100 daughters	2300	2188	3620	3000
	1 - 50 daughters	337	574	1613	857
	0 daughters	2861	2630	3090	3106
DFS		4260			
	> 200 daughters	480			
	101 - 200 daughters	2521			
	51 - 100 daughters	1232			
	1 - 50 daughters	27			
FRA		4951	5062	4893	4800
	> 200 daughters	398	425	329	376
	101 - 200 daughters	690	734	138	352
	51 - 100 daughters	3127	3217	2893	2965
	1 - 50 daughters	378	225	1040	603
	0 daughters	358	461	493	504
NLD		4078	4183	4101	4901
	> 200 daughters	976	911	291	522
	101 - 200 daughters	2889	2894	696	2951
	51 - 100 daughters	211	339	2600	545
	1 - 50 daughters	2	39	510	63
	0 daughters			4	820
NZL		2515	2507	2542	
	> 200 daughters	248	238	113	
	101 - 200 daughters	346	320	163	
	51 - 100 daughters	1532	1554	1595	
	1 - 50 daughters	29	35	306	
	0 daughters	360	360	365	
POL		1923	1945	1879	
	> 200 daughters		381	172	
	101 - 200 daughters		1130	384	
	51 - 100 daughters		379	1001	
	1 - 50 daughters		55	322	
USA		20222	20217		
	> 200 daughters	1247	1246		
	101 - 200 daughters	2144	2119		
	51 - 100 daughters	3681	3613		
	1 - 50 daughters	2143	2258		
	0 daughters	11007	10981		
	Total	**47615**	**43381**	**22797**	**19141**

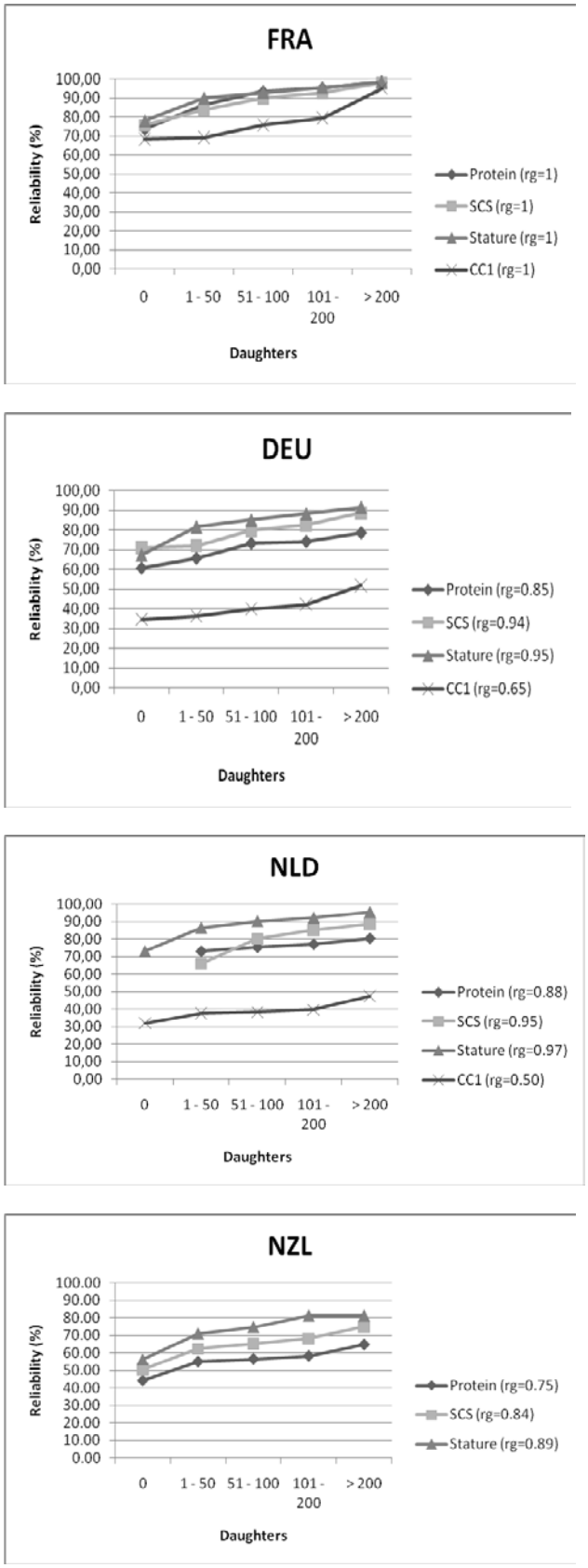

Figure 1. Average reliabilities of SGMACE GEBVs, according to the country of domestic GEBV and to the total number of daughters.

Table 2. Comparison of SGMACE EBVs and MACE EBVs, according to the country of origin of the GEBV taken by Interbull and to the total number of daughters.

		Protein						**SCS**						**Stature**						**Cow's Ability to Conceive**					
	nb of daugh.	N	corr	mean diff	std diff (%)	mean REL	REL gain	N	corr	mean diff	std diff (%)	mean REL	REL gain	N	corr	mean diff	std diff (%)	mean REL	REL gain	N	corr	mean diff	std diff (%)	mean REL	REL gain
DEU	> 200	1380	1,00	0,23	-2,3	78,2	0,2	1354	1,00	0,00	-2,4	88,1	0,4	625	1,00	0,01	-1,5	91,3	0,1	1086	0,99	0,07	3,1	50,8	1,2
	101-200	2787	1,00	0,26	-3,5	73,5	0,6	2721	0,99	0,01	-4,4	79,6	2,8	434	1,00	0,01	-1,0	87,6	0,6	1391	0,97	0,08	2,1	38,9	3,4
	51-100	2254	1,00	0,46	-4,0	72,2	1,2	2141	0,98	0,01	-4,7	74,2	**5,9**	3620	1,00	0,02	-2,4	83,6	1,5	3000	0,97	0,08	3,2	35,5	4,5
	1 - 50	53	0,99	-0,8	-1,7	67,4	3,6	51	0,92	0,06	-0,3	62,4	**14,0**	1572	0,99	0,03	-2,1	78,4	3,4	583	0,92	0,14	**9,0**	28,3	**8,3**
DFS	> 200	480	1,00	0,16	-3,8	79,4	0,1																		
	101-200	2521	1,00	0,14	-2,6	76,2	0,3																		
	51 - 100	1232	1,00	0,1	-1,6	74,3	0,7																		
	1 - 50	24	0,98	0,58	-0,7	64,9	3,4																		
FRA	> 200	398	1,00	-0,3	-1,5	98,5	0,1	425	1,00	0,00	0,7	97,4	0,5	329	1,00	0,00	0,3	98,6	0,1	376	0,98	0,08	4,4	94,6	0,5
	101-200	690	1,00	-0,7	-0,8	92,6	2,7	734	0,99	0,01	0,8	87,0	**5,7**	138	1,00	-0,01	2,4	94,0	1,6	352	0,91	0,07	8,1	69,5	**10,0**
	51-100	3127	0,99	-0,6	-1,7	89,2	4,2	3217	0,98	0,00	1,2	81,6	**8,2**	2893	0,99	-0,02	1,7	89,6	3,3	2965	0,91	0,07	10,2	63,3	**12,5**
	1 - 50	376	0,94	**-1,9**	-3,5	74,3	**12,4**	222	0,96	-0,01	3,3	68,3	**15,6**	1017	0,99	-0,01	1,1	85,1	**5,2**	597	**0,83**	0,15	15,8	46,6	**22,5**
NLD	> 200	976	1,00	0,12	-2,5	80,0	0,4	911	1,00	0,00	-3,4	88,1	0,7	291	1,00	0,01	-1,7	95,2	0,1	522	0,98	0,07	2,8	46,3	1,1
	101-200	2852	1,00	0,14	-3,3	76,4	0,8	2882	0,99	0,00	-3,1	83,3	1,8	696	1,00	0,02	-2,6	91,0	1,1	2951	0,98	0,05	3,7	38,8	0,9
	51 - 100	186	1,00	0,58	-2,8	74,6	1,2	289	0,99	0,01	-2,7	77,4	4,2	2599	1,00	0,02	-3,8	88,1	2,0	531	0,97	0,05	4,3	37,0	1,3
NZL	> 200	248	1,00	1,69	**-6,1**	64,6	0,1	238	1,00	0,01	0,1	74,6	0,5	113	1,00	**0,25**	**-13,3**	80,6	0,5						
	101-200	346	1,00	**2,17**	**-7,2**	57,4	0,9	320	0,98	0,00	-0,9	63,7	4,5	160	1,00	**0,18**	**-14,0**	80,1	1,1						
	51-100	1529	0,99	**1,87**	**-6,7**	54,6	1,9	1551	0,96	0,00	-0,3	58,2	**6,9**	1595	0,99	**0,24**	**-13,8**	72,3	2,4						
	1 - 50	26	0,96	**1,88**	**-6,1**	51,6	3,6	32	0,93	0,02	1,9	51,9	**10,5**	286	0,98	**0,23**	**-12,6**	65,7	**5,5**						
POL	> 200	389	1,00	**1,98**	**-5,9**	75,5	0,3	381	1,00	0,02	-4,0	84,2	0,2	172	0,99	0,07	**-6,0**	83,2	0,1						
	101-200	1131	0,99	**2,44**	**-6,0**	69,3	1,2	1130	0,99	0,00	-4,3	78,6	0,9	384	0,98	0,06	**-8,8**	79,5	0,5						
	51-100	376	0,99	**2,55**	-4,7	65,8	2,5	379	0,98	-0,02	-2,1	74,6	2,2	1001	0,97	0,09	**-8,1**	76,0	1,3						
	1 - 50	27	0,97	**2,93**	**-6,4**	54,7	**7,6**	54	0,89	-0,16	**14,0**	52,9	**10,1**	321	0,96	**0,12**	**-10,4**	70,4	3,5						
USA	> 200	1232	1,00	-0,5	-1,0	85,1	0,4	1231	0,99	-0,01	-1,0	85,0	0,9												
	101-200	2115	0,98	-1,3	-4,4	77,4	1,7	2089	0,96	-0,01	-2,6	72,3	4,3												
	51-100	3629	0,97	-1,3	**-5,3**	74,5	2,7	3562	0,94	-0,01	-1,9	67,0	**6,8**												
	1 - 50	597	0,96	**-2,6**	**-6,1**	65,8	8,6	690	0,86	-0,01	4,4	55,5	**15,4**												

Corr = Correlation between EBVs; mean diff = mean difference between EBVs (SGMACE – MACE); std diff % = difference between stds of SGMACE and MACE EBVs, expressed in % of std SGMACE; Mean Rel = average reliability of MACE EBV; Rel Gain = average of difference between SGMACE and MACE reliabilities (SGMACE – GMACE)

In bold: mean difference of more than 10% of one genetic standard deviation, or variation in stds of more than 5% or average change in reliabilities of more than 5%, or correlation of less than 0.9.

Table 3. Comparison of SGMACE EBVs and French domestic GEBVs, according to the country of origin of the GEBV taken by Interbull and to the total number of daughters.

		Protein						**SCS**						**Stature**						**Cow's ability to conceive**					
	nb of daugh.	Number of bulls	Corr	mean diff	std diff (%)	Mean REL	REL gain	Number of bulls	Corr	mean diff	std diff (%)	Mean REL	REL gain	Number of bulls	Corr	mean diff	std diff (%)	Mean REL	REL gain	Number of bulls	Corr	mean diff	std diff (%)	Mean REL	REL gain
DEU	> 200	478	0,98	0,62	-3,6	89,1	**-8,2**	471	0,99	0,02	-3,7	92,3	-2,7	247	0,98	0,00	-0,7	93,3	-1,2	375	**0,73**	**-0,17**	**-19,7**	79,7	**-24,6**
	101-200	628	0,98	-0,46	-3,1	86,3	**-10,4**	576	0,99	0,02	**-8,6**	87,9	-4,7	152	0,99	0,01	-1,9	89,3	-0,6	340	**0,72**	**-0,13**	**-25,9**	72,9	**-27,7**
	51-100	453	0,98	-0,25	-4,1	86,5	**-9,7**	362	0,98	0,03	**-9,2**	86,6	**-5,0**	775	0,98	0,00	-3,0	86,0	-0,8	639	**0,74**	-0,08	**-19,2**	71,9	**-29,1**
DFS	> 200	108	0,97	-0,48	**-7,0**	89,1	**-7,6**																		
	101-200	359	0,98	0,55	-4,5	86,5	**-9,4**																		
	51-100	219	0,98	0,61	-4,8	86,1	**-10,2**																		
FRA	> 200	398	1,00	0,00	0,0	95,0	3,6	425	1,00	0,00	0,2	94,9	3,0	329	1,00	0,00	0,0	95,0	3,7	376	1,00	0,00	-0,1	92,2	3,0
	101-200	690	1,00	-0,01	0,0	93,6	1,7	734	1,00	0,00	0,2	91,8	1,0	138	1,00	0,00	0,4	93,3	2,3	352	1,00	0,00	-0,4	78,5	1,0
	51-100	3127	1,00	0,01	0,1	91,4	2,1	3217	1,00	0,00	0,0	88,9	1,0	2893	1,00	0,00	0,1	90,0	2,9	2965	1,00	0,00	-0,1	75,3	0,5
	1 - 50	378	1,00	0,03	0,3	83,7	3,0	225	1,00	0,00	0,7	82,0	1,8	1040	1,00	0,00	0,1	86,8	3,2	603	1,00	0,00	0,0	68,5	0,6
	0	358	1,00	0,23	-1,2	71,0	2,6	461	1,00	0,00	-0,2	73,1	2,5	493	1,00	0,00	0,1	75,2	2,8	504	1,00	0,00	0,0	65,3	2,9
NLD	> 200	638	0,98	0,71	-3,9	89,9	**-8,5**	594	0,98	0,06	**-5,2**	92,0	-2,7	234	0,99	0,03	-0,7	94,3	1,3	369	**0,69**	**-0,10**	**-13,7**	76,7	**-25,8**
	101-200	1268	0,99	1,11	**-7,1**	88,1	**-10,3**	1285	0,98	0,05	**-7,3**	89,6	-3,8	361	0,98	0,06	-0,8	89,9	2,5	1452	**0,55**	**-0,16**	**-17,4**	70,4	**-28,5**
	51-100	83	0,99	**2,71**	**-5,1**	87,1	**-10,8**	114	0,98	0,02	**-9,6**	87,6	**-5,0**	1225	0,95	0,06	-2,0	86,6	3,7	197	**0,60**	0,03	**-17,6**	68,1	**-27,6**
	1 - 50	2						2						168	**0,86**	0,05	-2,2	78,8	**8,5**	2					
USA	> 200	160	0,99	0,02	-1,3	93,5	0,2	164	0,98	-0,01	-2,1	94,0	0,5												
	101-200	32	0,98	0,13	**-5,8**	85,8	-4,2	32	0,96	0,06	-1,9	84,4	-1,8												
	51-100	27	0,95	**-1,63**	-0,9	84,7	**-5,5**	28	0,94	-0,06	**-6,4**	82,0	-3,1												
	0	61	**0,72**	**3,59**	**-6,6**	71,9	-1,1	52	**0,81**	0,13	**-13,0**	67,6	1,1												

Corr = Correlation between EBVs; mean diff = mean difference between EBVs (SGMACE – GEBV); std diff % = difference between stds of SGMACE and French GEBVs, expressed in % of std SGMACE; Mean Rel = average reliability of French GEBV; Rel Gain = average of difference between SGMACE and French GEBV reliabilities (SGMACE – GEBV)

In bold: mean difference of more than 10% of genetic standard deviation, or variation in stds of more than 5%, or average change in reliabilities of more than 5%, or correlation of less than 0.9.