2012 年 3 月 1 日
（独）家畜改良センター
改良部　情報分析課

インターブルからの国際評価方法変更のお知らせ

インターブルでは、メイス(MACE：Multiple-trait Across Country Evaluation：多国間評価)法を用い、参加各国の種雄牛について国別の遺伝的能力評価値を計算しています。これまでの評価では、種雄牛の母牛の血縁情報を直接利用せず、母牛の父及び母牛の母（遺伝グループ※）を用いていましたが、2012 年 4 月に行う国際評価以降、母牛の血縁情報を直接用いる方法に変更するそうです。これは、近年、種雄牛のみならず能力の高い雌牛が国際的に利用されるケースが増加していることにより、母牛を介した種雄牛間の結びつきが強くなってきたことが背景にあり、母牛の血縁情報を国際評価に直接用いることで、より精度の高い国際評価を行うことが可能という考えによります。

このことによって、インターブルでは、各国の国内種雄牛の評価値はあまり変動することはないものの、各国における海外種雄牛の評価値が変動する可能性のあることを示唆しています。

なお、詳細はインターブルが作成した「Fact sheet about SD-MACE」をご覧下さい。

※遺伝グループとは、遺伝的能力評価上血縁不明の扱いに関する用語であり、インターブルでは、これら血縁不明個体（母の母牛）を原産国や誕生年でグループ化し同一グループに属する複数の個体を同一個体と仮想して評価を行っている。

Fact sheet about SD-MACE

Summary - Changes in proofs and reliabilities with new MACE model

The Interbull Community has decided to introduce a new MACE model including relationships on bull dams. The background for the change is to move genetic groups further away from animals with data in order for them to have less impact on the proofs. The consequence is changes in proofs especially for bulls with no progeny test in own country and an average increase in reliabilities. The main reason for changes in proofs for this group of bulls is that the parent average of the bull is computed differently for sire-dam (SD)-MACE compared to the sire-maternal-grandsire(S-MGS)-MACE model due to the change in pedigree structure. This due to the fact that the bull dam in the SD-MACE model gets a breeding value based on the relatives she has in the system. A national breeding value of the bull dam is not included in the MACE model. The breeding value of the dam is therefore only influenced by the performance of her relatives in the MACE system. A very positive performance of a dam, solely based on her relatives, will give a boost to a parent average of a bull compared to the parent average he had in the S-MGS system. A change in the parent average of a bull will therefore impact his converted proofs to other country scales and is the main cause of changes between systems. The usage of the sire-dam pedigree gives the MACE system more information on the genetic background of a bull. In case a dam has several sons tested in several countries, better links between countries are created.

Background

In every breeding value prediction unknown parents are assigned to phantom parent groups (PHGs). These groups are of a certain size and in MACE based on animals of a certain origin, birth year and selection path. A group is treated like an animal and the same genetic group can have very different impact on the proof of the same animal in different country scales. In order to minimize the impact of these PHGs, female relationships were included in the pedigree in the new SD-MACE model.

Bull dams in MACE model

National evaluation centers are often facing the problem of overestimated bull dams in national genetic evaluations. The difference in national evaluation models and international evaluation models is however that the proof of the dam is included in the national evaluation model while the dam only is included via pedigree relationships in the international model. MACE is using as input the breeding values of AI-tested bulls and the pedigree of the bulls. If the breeding value of a young AI-bull is overestimated in his national evaluation an overestimated breeding value will be submitted to Interbull. This is however no difference irrespectively if Interbull is using Sire-Maternal-Grandsire (S-MGS) or Sire-Dam (S-D) pedigree relationships.

Global Genetic Trend

The global genetic trend is unchanged by change of model. Examples for protein (pro), somatic cell count (scs), longevity (dlo), and fertility (T5 – int) for the Holstein and Red Dairy Cattle breeds both on DFS scale are shown in Figure 1 and Figure 2, respectively.

Having no change in global genetic trends does not mean that bull proofs do not change but only that the mean of bull proofs do not change.

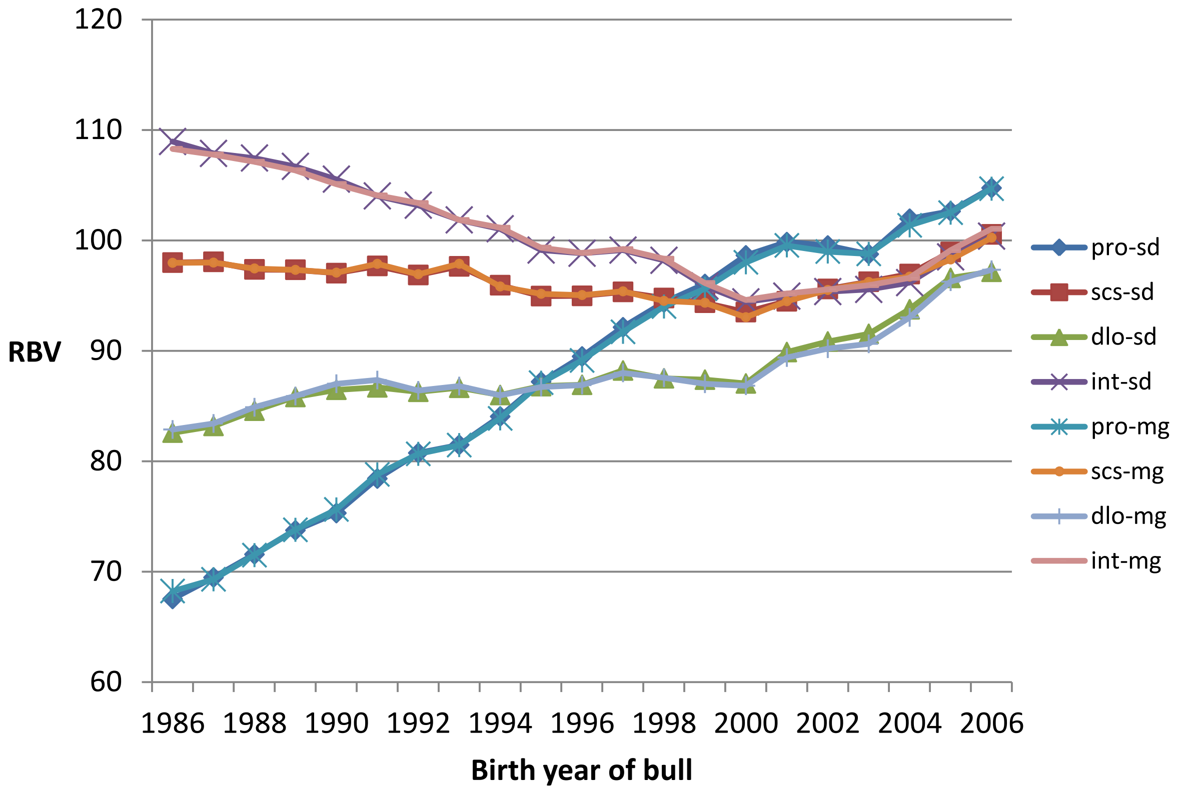

Figure 1. Global genetic trend for protein (pro), SCS, longevity (dlo) and fertility (int) for Holstein on DFS scale (100, 10) for SD-MACE (sd) and S-MGS MACE (mg) models

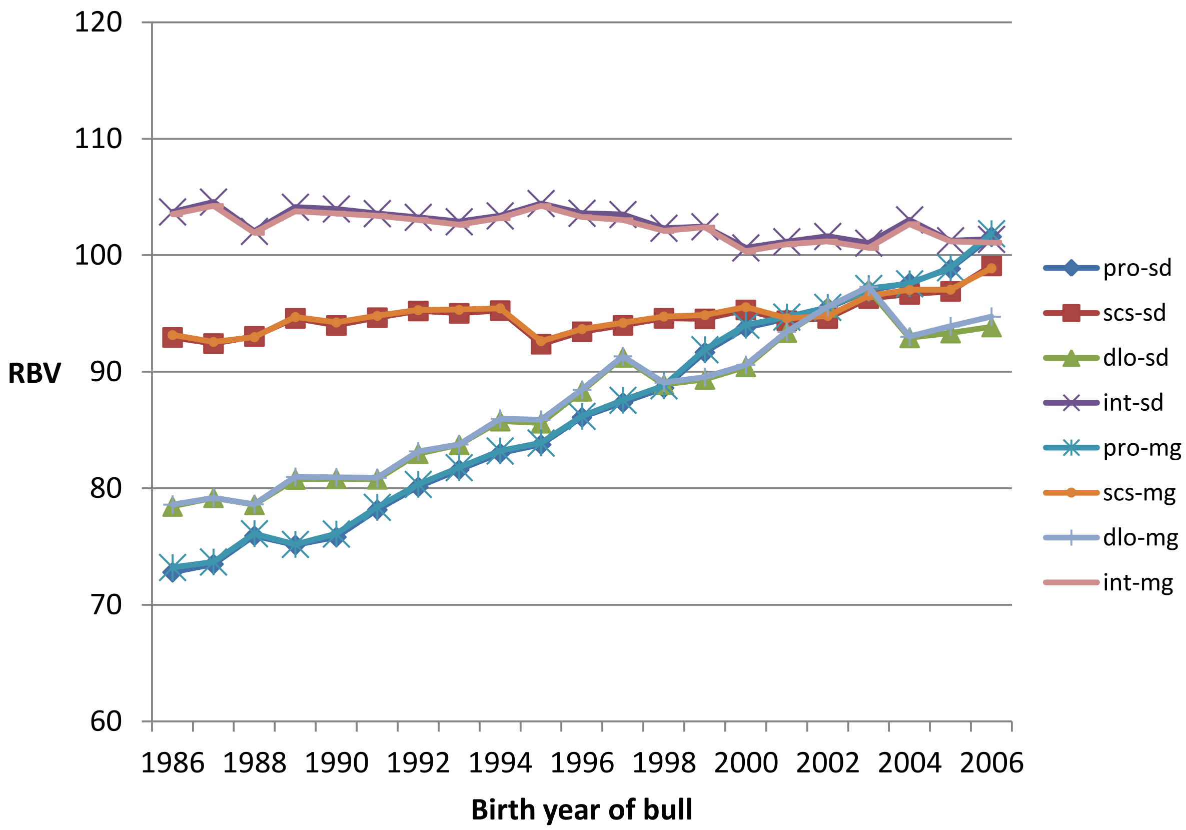

Figure 2. Global genetic trend for protein (pro), SCS, longevity (dlo) and fertility (int) for Red Dairy Cattle on DFS scale (100, 10) for SD-MACE (sd) and S-MGS MACE (mg) models

Re-ranking

Even if the global genetic trend is unchanged we see re-ranking of bulls. Therefore, when some bulls will get an increase in their proofs compared to the old model, some other bulls will get a decrease in their proofs compared to the old model.

Which bulls will have the largest change in proofs

A bull with a progeny test in only one country will get his proof converted to other country scales using equation 1.

$$IBV_{bull(imp)} = PA_{bull(imp)} + cor_{imp,exp} (SD_{imp} / SD_{exp}) * (proof_{exp} - PA_{bull(exp)}) \quad [1]$$

Where

$IBV_{bull(imp)}$ = International breeding value of bull in importing country
$PA_{bull(imp)}$ = Parent average of bull in importing country
$cor_{imp,exp}$ = Genetic correlation between importing and exporting country
SD_{imp} = Sire standard deviation in importing country
SD_{exp} = Sire standard deviation in exporting country
$proof_{exp}$ = Bull proof in exporting country
$PA_{bull(exp)}$ = Parent average of bull in exporting country

We name the country of progeny test as exporting (exp) country and the country scale where the proof is converted to importing (imp) country. When changing from a S-MGS pedigree structure to a SD-pedigree structure the SD's have also increased. An example of percentage change in sire SD when changing model can be seen in Figure 3 for parallel runs conducted during April 2011 and August 2011 for protein in Holsteins.

If sire SDs in all countries changes with the same percentage no re-ranking will occur due to these changes. However, what matters in terms of re-ranking by changes in sire standard deviations is the ratio between two countries. Therefore, if the increase in sire SD is the same for two country combinations a change in converted proofs is caused by other factors than the change in sire SD. As correlations are unchanged the only parts that are left to change are the PA's of the bull in importing and exporting country, respectively. In the SD-MACE model parent average are computed as equation 2:

$$PA_{bull} = \tfrac{1}{2}\, BV_{sire} + \tfrac{1}{2}\, BV_{dam} \qquad [2]$$

Where

PA_{bull} = International parent average of the bull
BV_{sire} = International breeding value of the sire
BV_{dam} = International breeding value of the dam

while parent average in the S-MGS model was computed as equation 3:

$$PA_{bull} = \tfrac{1}{2} BV_{sire} + \tfrac{1}{4}\, BV_{mgs} + \tfrac{1}{4}\, BV_{mgd\text{-}gr} \qquad [3]$$

Where

PA_{bull} = International parent average of the bull
BV_{sire} = International breeding value of the sire
BV_{mgs} = International breeding value of the maternal grand sire
$BV_{mgd\text{-}gr}$ = International breeding value for maternal grand dam group
As parent averages are computed differently than before they are prone to change by change of model.

In order to investigate if average change in proofs for protein by change of model is the same for local and foreign bulls, the bulls were divided in these two categories. The study was done for Holstein bulls on German scale and the results are shown in Figure 4. The figure shows that no average change are observed for bulls progeny tested in Germany (local bulls) while a small average increase was observed for bulls not progeny tested in Germany (foreign bulls). However, having a standard deviation of the proofs around 24 gives a very minimal average increase in proofs of foreign bulls.

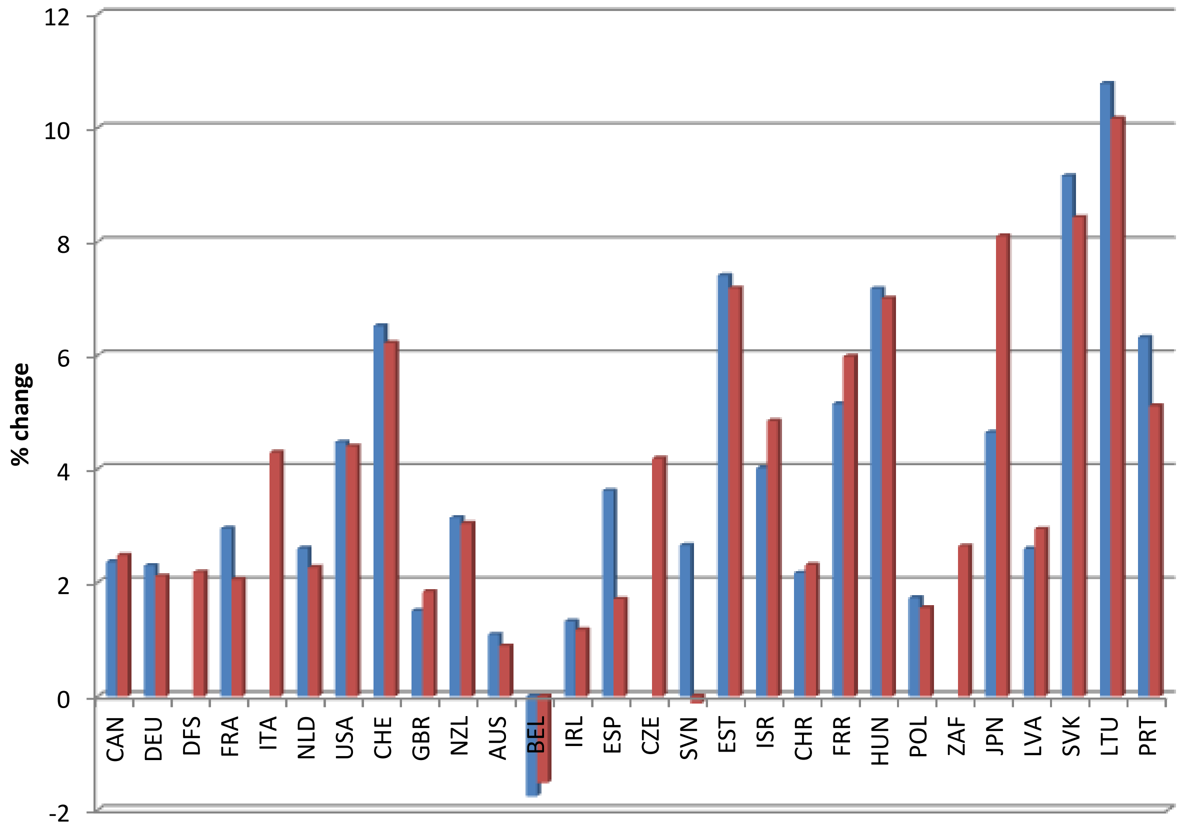

Figure 3. Percent changes in sire standard deviation for protein by change of model from S-MGS to SD-model. In red (April 2011) in blue (August 2011).

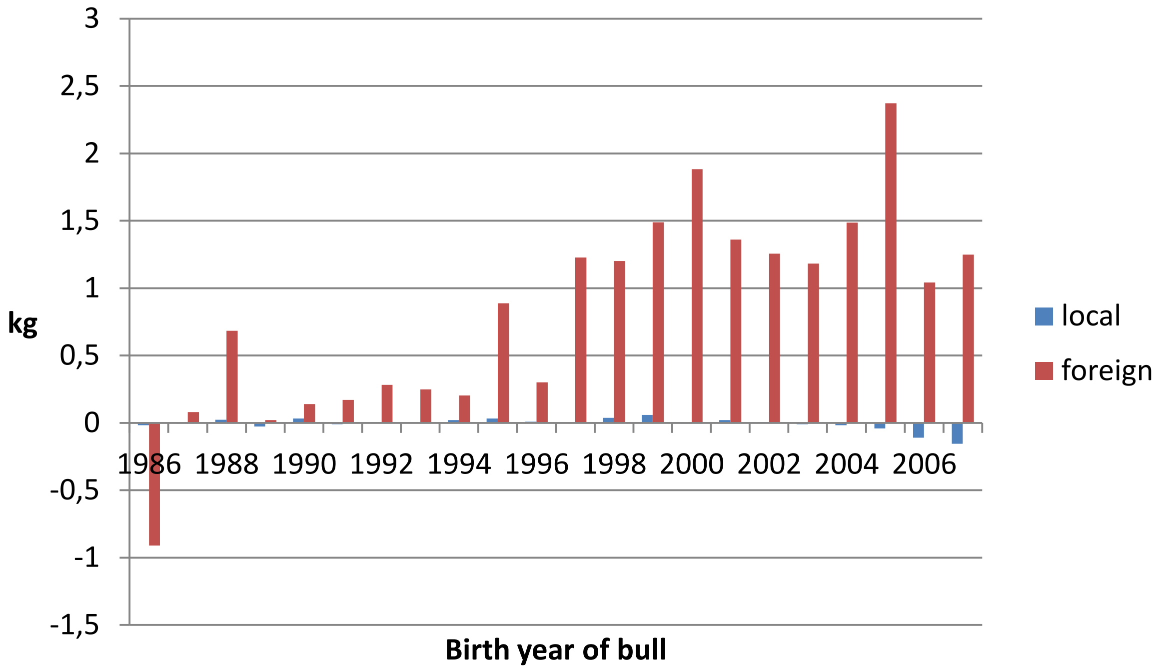

Figure 4. Average change in kg protein for Holstein proofs on German scale by change of model from S-MGS to SD-model.

In order to further investigate further the variation in the changes between models for two different breeds and for two different traits the DFS scale was chosen as they are expressed in an RBV scale for both traits with a mean of 100 and a standard deviation of 10. Table 1 and Table 2 show the average, minimum and maximum change in proof of local and foreign bulls for protein for HOL and RDC. Only every second year is shown in the tables. The difference is computed as SD-proof minus S-MGS-proof. The table shows almost no change for local bulls while foreign bulls on DFS scale changes. The average change is small but some foreign bulls will have a decrease in proofs and other bulls will have an increase in proofs on DFS scale. The mean increase in proofs of foreign bulls on DFS scale is positive for the HOL breed and negative for the RDC breed, which may be caused by the different structure of the two populations caused by the fact that the main population of RDC cattle is in the Nordic countries while other countries house the main part of the Holstein population. For the RDC population the variation in the difference is smaller compared to the HOL breed. This may be caused by smaller cow families for the RDC breed compared to the HOL breed. Cow-families are both based on number of progeny per bull dam as well as number of half-sibs etc. An illustration of number of progeny per bull dam for Interbull evaluations is shown in Figure 5. The figure shows more sons per bull dam for the HOL breed compared to the RDC breed.

Protein is a trait with a strong positive trend over time. In order to investigate if the picture is similar for a trait with a flatter trend the same computations were carried out for somatic cell score (SCS) for HOL and RDC on DFS scale. Again we observe a larger change for foreign bulls on local scale compared to local bulls on local scale and also a smaller spread in breeding values for the RDC breed compared to the HOL breed.

The 27 Holstein bulls with the largest increase in protein proof by change of model were identified on the German scale. The bulls and their pedigrees are listed in APPENDIX I. A general picture for all the bulls in this list is that they are all bulls with no progeny test in Germany and the dams of these bulls are all daughters of sires with very many AI sons and bull dams indicating an impact of a family with a positive performance on the breeding value of the dam in the bull list.

Table 1. Average (Avr), minimum (Min) and Maximum (Max) change in Protein per birth year of local and foreign HOL bulls on DFS scale. RBV Scale (100; 10)

	Local			Foreign		
	Avr	Min	Max	Avr	Min	Max
1986	-0.08	-3.79	1.06	-0.81	-8.78	6.47
1988	-0.03	-0.92	1.46	0.19	-6.35	6.04
1990	-0.07	-2.53	0.86	-0.27	-6.11	6.25
1992	-0.03	-0.97	1.31	0.13	-9.22	5.25
1994	0.04	-0.99	1.77	0.38	-6.89	5.55
1996	0.07	-1.27	6.78	0.57	-10.46	5.89
1998	0.09	-1.16	1.54	0.59	-5.63	5.47
2000	0.05	-1.66	4.76	0.96	-6.58	6.90
2002	0.09	-0.96	2.55	1.14	-6.85	7.52
2004	0.05	-0.65	1.58	0.78	-6.43	7.12
2006	0.03	-3.41	1.17	0.65	-7.34	5.65

Table 2. Average (Avr), minimum (Min) and Maximum (Max) change in Protein per birth year of local and foreign RDC bulls on DFS scale. RBV Scale (100; 10)

	Local			Foreign		
	Avr	Min	Max	Avr	Min	Max
1982	0.01	-1.06	0.40	-0.40	-4.46	2.20
1984	0.02	-0.61	1.42	-0.65	-4.11	1.45
1986	-0.01	-1.20	0.64	-0.68	-3.93	1.57
1988	-0.01	-1.32	0.23	-0.37	-4.64	1.99
1990	0.00	-1.47	0.29	-0.54	-3.82	2.14
1992	-0.01	-0.50	0.31	-0.44	-3.84	2.95
1994	0.00	-0.34	0.20	-0.32	-4.38	2.07
1996	0.00	-0.19	0.15	-0.10	-3.98	2.18
1998	0.00	-0.26	0.18	-0.44	-4.26	2.58
2000	0.02	-0.18	0.85	-0.17	-3.96	2.05
2002	0.04	-0.13	1.11	0.16	-4.12	2.22
2004	0.01	-0.36	0.96	-0.15	-3.77	2.16
2006	0.03	-0.99	0.24	-0.52	-4.08	1.99

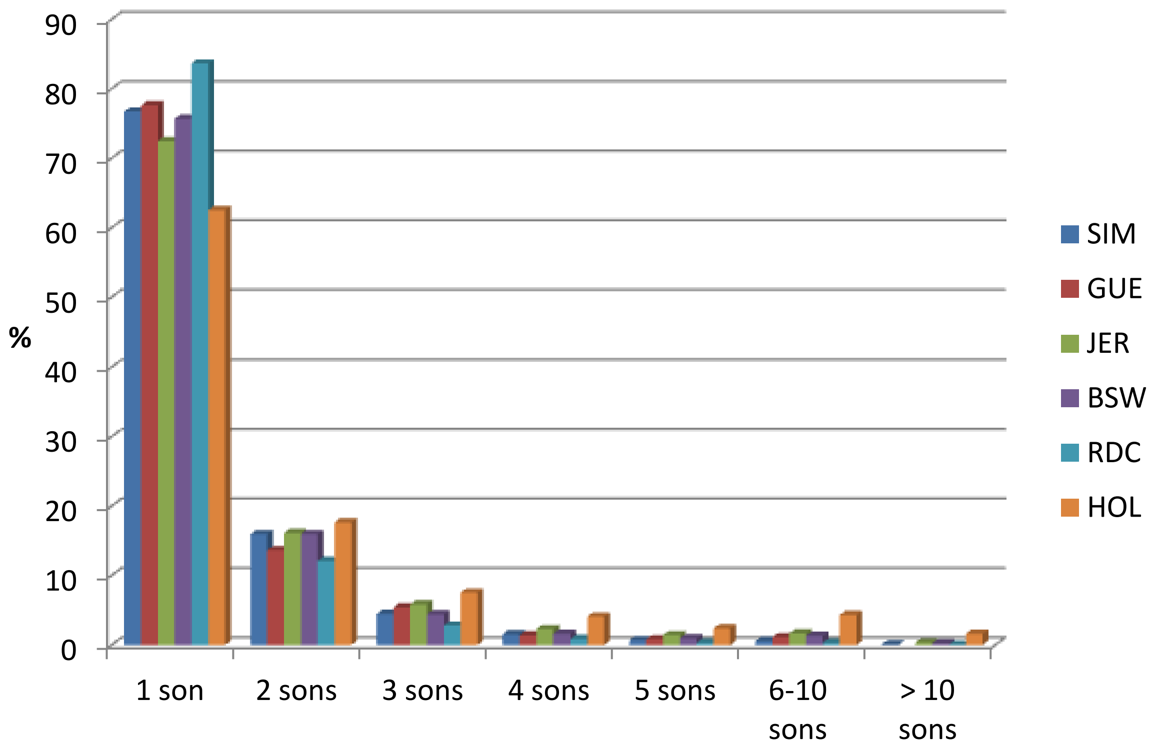

Figure 5. Percent of bull dams with one or more sons

Table 3. Average (Avr), minimum (Min) and Maximum (Max) change in Somatic Cells per birth year of local and foreign HOL bulls on DFS scale. RBV Scale (100; 10)

	Local			Foreign		
	Avr	Min	Max	Avr	Min	Max
1986	-0.01	-3.23	1.12	0.03	-12.60	5.05
1988	0.04	-1.69	1.66	-0.07	-5.27	4.38
1990	0.02	-1.54	1.59	-0.14	-5.62	3.90
1992	-0.05	-2.18	2.13	-0.13	-34.08	4.83
1994	0.03	-1.26	2.20	0.07	-6.77	7.43
1996	0.07	-2.03	1.92	-0.10	-7.79	4.47
1998	0.05	-1.74	2.06	0.25	-7.46	5.71
2000	0.06	-1.08	1.83	0.44	-4.29	6.35
2002	0.05	-1.76	1.21	0.08	-6.20	4.96
2004	0.04	-1.39	2.28	0.27	-6.03	4.93
2006	-0.11	-4.22	1.55	0.54	-6.75	4.97

Table 4. Avrerage (Avr), minimum (Min) and Maximum (Max) change in Somatic cell per birth year of local and foreign RDC bulls on DFS scale. RBV Scale (100; 10)

	Local			Foreign		
	Avr	Min	Max	Avr	Min	Max
1982	0.01	-0.54	0.52	-0.36	-2.51	3.02
1984	0.00	-1.64	1.25	0.03	-2.45	3.87
1986	-0.01	-3.55	0.86	-0.16	-2.25	3.38
1988	0.02	-0.27	1.00	-0.24	-2.19	3.51
1990	0.02	-0.91	0.61	-0.39	-2.61	1.75
1992	0.04	-0.52	0.59	-0.26	-2.57	1.88
1994	-0.02	-0.29	0.20	-0.36	-1.44	2.66
1996	0.01	-0.28	0.64	-0.37	-3.03	2.93
1998	0.02	-0.20	0.59	-0.32	-1.95	2.19
2000	0.01	-0.51	0.44	-0.65	-2.40	2.09
2002	0.04	-0.45	1.87	-0.30	-3.00	1.85
2004	-0.01	-0.87	0.18	-0.79	-5.15	1.52
2006	0.06	-0.68	1.70	-0.72	-3.02	0.61

Partitioning of single bull proof with large change

Changes in bull proofs were further investigated by partitioning of proofs from the two models. For this example the first bull in Appendix I was chosen HOLFRAM004403435205 RHODIA LTZ. The different parts were put in equation 1 having Germany as importing country and France as exporting country.

$BV_{bull(DEU)} = PA_{bull(DEU)} + cor_{DEU,FRA} * (SD_{DEU} / SD_{FRA}) * (proof_{FRA} – PA_{bull(FRA)})$

S-MGS model:

$IBV_{bull(DEU)}$ = 23.408 + 0.852525 * (2 * 8.6359 / 2 * 9.1271) * (53.507 - 12.091) = 56.8160

Predicted BV: 56.8160

SD-model:

$IBV_{bull(DEU)}$ = 37.407 + 0.852525 * (17.65628 / 18.79330) * (53.490 – 18.459) = 65.4569

Predicted BV: 65.4569

The partitioning of proof shows that the change in international breeding value of HOLFRAM004403435205 is due to the change in PA of the bull.

Changes in reliabilities

In general an increase in reliabilities is observed when change of model. This is caused by an increase in connectedness.

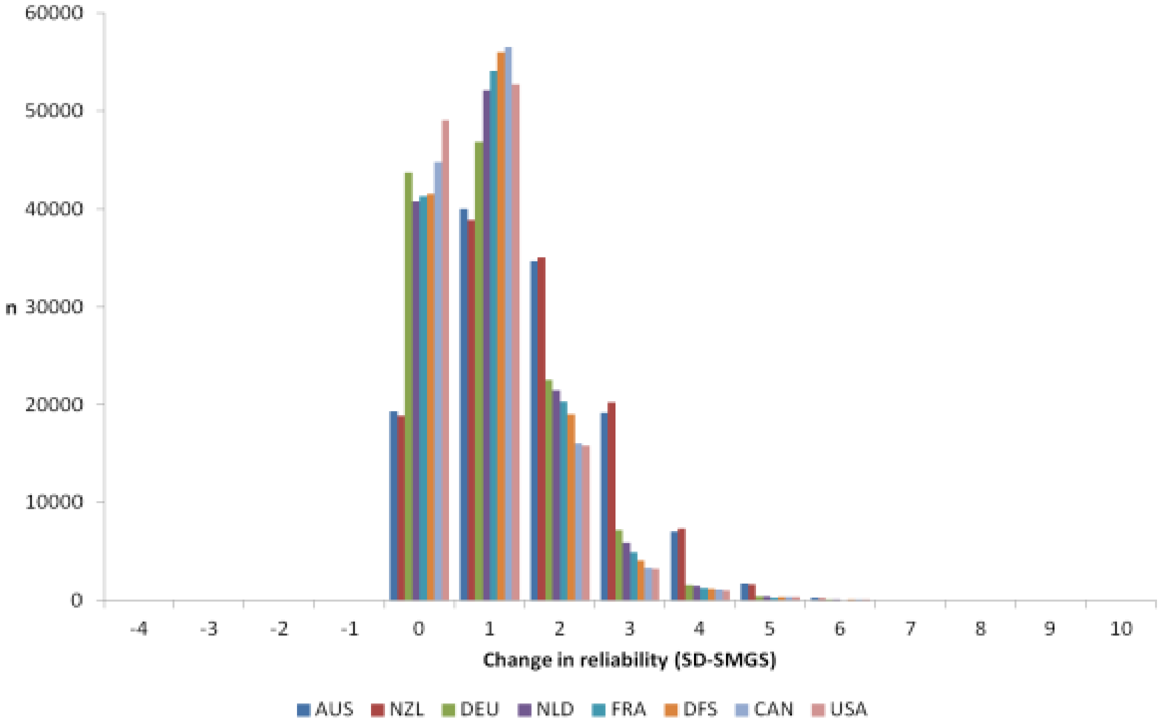

Figure 6. Increase in reliability for protein on different country scales.

APPENDIX I. Bull top list for large increases in protein proofs on German scale (Jan 2011)

Bull	bull name	b-yr	sire	sire name	dam	mgs	mgs name	no sons of mgs	no dtr of mgs
HOLFRAM004403435205	RHODIA LTZ	2000	HOLUSAM000002266008	Lantz	HOLFRAF004495050238	HOLNLDM000460508522	Celsius	1576	1518
HOLJPNM000000053508	STRELITZIA MIRACLE JUSTICE ET	2005	HOLUSAM000122358313	O-Man	HOLJPNF000695402042	HOLUSAM000002290977	Marshall	552	486
HOLFRAM003704256595	RUCHEL JAR	2000	HOLFRAM004494050236	Jarny	HOLFRAF003798006048	HOLUSAM000002183007	Manfred-ET	724	532
HOLUSAM000062030892	MARKLAND MAN WINSTON CRI-ET	2005	HOLUSAM000122358313	O-Man	HOLUSAF000131652910	HOLUSAM000002290977	Marshall	552	486
HOLUSAM000062868184	CO-OP TREDWAY FIREBALL-ET	2005	HOLUSAM000123982137	Tredway	HOLUSAF000061089267	?	?	MGS of dam Manfred-ET	
HOLUSAM000061547529	PENN-ENGLAND DELLA OGDEN-ET	2004	HOLUSAM000122358313	O-Man	HOLUSAF000207186592	HOLUSAM000002266008	Lantz	952	552
HOLFRAM007968830254	SIRAC BR	2001	HOLUSAM000002289548	Brett	HOLFRAF007997053389	HOLFRAM002991000305	Gibbon	744	782
HOLUSAM000061869635	SPRINGHILL-OH CONVICTION-ET	2004	HOLUSAM000122358313	O-Man	HOLUSAF000060178828	HOLNLDM000839380546	Addison	998	1086
HOLUSAM000052323649	GLEN-D-HAVEN OMAN SILVA-ET	2004	HOLUSAM000122358313	O-Man	HOLUSAF000050426692	HOLUSAM000002265005	Aaron	871	922
HOLUSAM000135602690	HUMDINGER O MAN GIANT-ET	2004	HOLUSAM000122358313	O-Man	HOLUSAF000131041392	HOLUSAM000002250783	Durham	397	624
HOLJPNM000000053419	BRIDGE-BOAT AMBER JONIOUS ET	2004	HOLUSAM000122358313	O-Man	HOLUSAF000017216843	HOLUSAM000002160458	Patron	866	1292
HOLUSAM000061642077	PARADISE-R FRANCHISE	2004	HOLUSAM000122358313	O-Man	HOLUSAF000060446359	HOLUSAM000002290977	Marshall	552	486
HOLUSAM000132660646	FUSTEAD HERSHEL BOOMER-ET	2001	HOLUSAM000002294436	Hershel	HOLUSAF000125946746	HOLUSAM000002183007	Manfred-ET	724	532
HOLFRAM002253771905	VIA THELO	2004	HOLUSAM000122358313	O-Man	HOLFRAF002253771782	HOLFRAM001095001791	Lorak	67	59
HOLUSAM000136333380	WA-DEL ALTAMIRA-ET	2004	HOLUSAM000122358313	O-Man	HOLUSAF000132141910	HOLUSAM000002294436	Hershel	683	296
HOLUSAM000136404884	MR EGAN-ET	2005	HOLUSAM000122358313	O-Man	HOLUSAF000129740913	HOLUSAM000002265005	Aaron	871	922
HOLUSAM000062030806	CO-OP OMAN LIZARD-ET	2004	HOLUSAM000122358313	O-Man	HOLUSAF000060475875	HOLUSAM000002290977	Marshall	552	486
HOLUSAM000135746776	LONG-LANGS OMAN OMAN-ET	2004	HOLUSAM000122358313	O-Man	HOLUSAF000130677626	HOLUSAM000002265005	Aaron	871	922
HOLUSAM000061894965	WALNUT-S NICOLAS-ET	2003	HOLUSAM000120780521	Finley	HOLCANF000007255524	HOLUSAM000002249055	Convincer	1775	1708
HOLUSAM000052805723	SCHILLVIEW OMAN GERARD-ET	2005	HOLUSAM000122358313	O-Man	HOLUSAF000050546487	HOLUSAM000002290977	Marshall	552	486
HOLUSAM000063082289	WELCOME STRUTTER-ET	2006	HOLUSAM000130153294	Marion	HOLUSAF000061641113	HOLUSAM000122358313	O-Man	1576	1518
HOLUSAM000135691067	TOMLU OMAN DOTSON-ET	2004	HOLUSAM000122358313	O-Man	HOLUSAF000129764377	HOLUSAM000002250783	Durham	397	624
HOLUSAM000135563126	CLOVER-VALLEY O-MAN ABS	2004	HOLUSAM000122358313	O-Man	HOLUSAF000060859759	HOLUSAM000002250783	Durham	397	624
HOLFRAM005703552576	VAORIST	2004	HOLUSAM000122358313	O-Man	HOLFRAF005703389502	HOLUSAM000002294436	Hershel	683	296
HOLUSAM000064552203	TEL-SAL SANDERSON	2006	HOLUSAM000060301421	Encino	HOLUSAF000137788035	HOLUSAM000122358313	O-Man	1576	1518

HOLUSAM000062030919	CO-OP MURPHY LANDEN-ET	2005	HOLUSAM000128920633	Murphy	HOLUSAF000060475875	HOLUSAM000002290977	Marshall	552	486
HOLFRAM001524223202	VIMERVIEW	2004	HOLUSAM000122358313	O-Man	HOLUSAF000131173433	HOLUSAM000002290977	Marshall	552	486
HOLFRAM007943400283	TELERA SAT	2002	HOLUSAM000017099649	Saturn	HOLUSAF000130388131	HOLAUSM000A00009209	Donor	282	198
HOLUSAM000062030789	CO-OP OMAN LLOYD-ET	2004	HOLUSAM000122358313	O-Man	HOLUSAF000060475875	HOLUSAM000002290977	Marshall	552	486
HOLFRAM002244284222	URBIEL	2003	HOLUSAM000017131025	Garter	HOLUSAF000129843166	HOLNLDM000839380546	Addison	998	1086
HOLUSAM000062769013	CO-OP OMAN TOUGH GUY-ET	2006	HOLUSAM000122358313	O-Man	HOLUSAF000060807929	HOLUSAM000017131025	Garter	615	708
HOLUSAM000062030793	CO-OP OMAN LOGAN-ET	2004	HOLUSAM000122358313	O-Man	HOLUSAF000060475875	HOLUSAM000002290977	Marshall	552	486
HOLFRAM001448435552	VIJUST	2004	HOLUSAM000122358313	O-Man	HOLFRAF001448435254	HOLUSAM000002266008	Lantz	952	552
HOLUSAM000063927723	MORNINGVIEW LEVI	2006	HOLUSAM000130588960	Buckeye	HOLUSAF000135404694	HOLUSAM000122358313	O-Man	1576	1518
HOLFRAM002244592081	VIVIO	2004	HOLUSAM000122358313	O-Man	HOLFRAF002244591912	HOLFRAM005694028588	Jocko Besn	1094	1759
HOLUSAM000135774702	END-ROAD O-MAN BRONCO-ET	2004	HOLUSAM000122358313	O-Man	HOLUSAF000131926022	HOLUSAM000002290977	Marshall	552	486
HOLUSAM000135555774	CHARLESDALE STRATUSPHERE-ET	2004	HOLDEUM000578194407	Lancelot	HOLUSAF000133701030	HOLUSAM000122358313	O-Man	1576	1518