

INTRODUCTION

The latest genomic test international evaluation for females fertility traits took place as scheduled at the Interbull Centre. Data from 20 countries were included in this evaluation.

International genetic evaluations for fertility traits of bulls were computed from:  
 AUS BEL CAN CHE CZE DEU DFS ESP FRA GBR IRL ISR ITA NLD NZL POL USA ZAF URY JPN  
 Holstein data were included in this evaluation.

BEL, CAN, DEU, FRA, DFS, GBR, ITA, NLD, POL submitted GEBVs.

cc1: CAN, DEU, , FRA, DFS, GBR, ITA, NLD, POL  
 cc2: BEL, CAN, DEU, ESP, , DFS, GBR, ITA, NLD, POL  
 crc: BEL, CAN, DEU, ESP, FRA, DFS, GBR, ITA, NLD, POL  
 hco: CAN, DEU, , FRA, DFS, , ITA, NLD, POL  
 int: BEL, CAN, DEU, ESP, , DFS, GBR, ITA, NLD, POL

Based on a decision made by Interbull Steering committee in August 2007, female fertility traits are classified as follows:

- T1 (HC): Maiden (H)eifer's ability to (C)onceive. A measure of confirmed conception, such as conception rate (CR), will be considered for this trait group. In the absence of confirmed conception an alternative measure, such as interval first-last insemination (FL), interval first insemination-conception (FC), number of inseminations (NI), or non-return rate (NR, preferably NR56) can be submitted;
- T2 (CR): Lactating (C)ow's ability to (R)ecycle after calving. The interval calving-first insemination (CF) is an example for this ability. In the absence of such a trait, a measure of the interval calving-conception, such as says oprn (DO) or calving interval (CI) can be submitted;
- T3 (C1): Lactating (C)ow's ability to conceive (1), expressed as a rate trait. Traits like conception rate (CR) and non-return rate (NR, preferably NR56) will be considered for this trait group;
- T4 (C2): Lactating (C)ow's ability to conceive (2), expressed as an interval trait. The interval first insemination-conception (FC) or interval first-last insemination (FL) will be considered for this trait group. As an alternative, number of inseminations (NI) can be submitted. In the absence of any of these traits, a measure of interval calving-conception such as days open (DO), or calving interval (CI) can be submitted. All countries are expected to submit data for this trait group, and as a last resort the trait submitted under T3 can be submitted for T4 as well.
- T5 (IT): Lactating cow's measurements of (I)nterval (T)raits calving-conception, such as days open (DO) and calving interval (CI).

Based on the above trait definitions the following traits have been submitted for international genetic evaluation of female fertility traits.

Country	Traits	Submitted traits and their definitions
AUS	T2=CY T4=C2 T5=IT	Calving interval converted to 42 days pregnancy rate Calving interval converted to 42 days pregnancy rate Calving interval converted to 42 days pregnancy rate
BEL	T2=CY T4=C2 T5=IT	PR=Pregnancy Rate ( $=\frac{21}{(DO-45+11)} \times 100$ , with DO=days open) PR=Pregnancy Rate ( $=\frac{21}{(DO-45+11)} \times 100$ , with DO=days open) PR=Pregnancy Rate ( $=\frac{21}{(DO-45+11)} \times 100$ , with DO=days open)
CAN	T1=HC T2=CY T3=C1 T4=C2 T5=IT	NR=Non Return Rate after 56 Days in heifers (NRR), % CF=Interval from Calving to First Service in cows (CF) NR=Non Return Rate after 56 Days in cows (NRR), % FC=Interval first insemination-conception in cows DO=Days open

CHE	T1=HC	CR=Heifers' Conception rate
	T2=CR	CF=Interval from Calving to First Service (ICF), days
	T3=C1	NR=Non Return Rate after 56 Days (NRR), %
	T4=C2	NR=Non Return Rate after 56 Days (NRR), %
CZE	T1=HC	CR=Heifers' Conception rate (pregnant or not after 3 months)
	T3=C1	CR=Cows' Conception rate (pregnant or not after 3 months)
	T4=C2	CR=Cows' Conception rate (pregnant or not after 3 months)
AUT/DEU	T1=HC	NR=Heifers' Non Return Rate after 56 days
	T2=CY	CF=Interval from calving to first insemination cows (days)
	T3=C1	NR=Cows' Non Return Rate after 56 days
	T4=C2	FL=Interval from first to last insemination cows (days)
	T5=IT	DO=Days open (days)
DFS	T1=HC	NR=Heifers' Non Return Rate after 56 days
	T2=CY	CF=Interval from calving to first insemination cows (days)
	T3=C1	NR=Cows' Non Return Rate after 56 days
	T4=C2	FL=Interval from first to last insemination cows (days)
	T5=IT	DO=Days open (days)
ESP	T2=CY	DO=Days open
	T4=C2	DO=Days open
	T5=IT	DO=Days open
FRA	T1=HC	CR=Heifers' Conception rate (binary trait) for maiden heifers
	T2=CY	Interval between calving and first AI
	T3=C1	CR=Cows' Conception rate (binary trait) for cows
	T4=C2	FL=Interval from first to last insemination cows (days)
GBR	T2=CY	CI=days between 1st and 2nd calvings
	T3=C1	NR=1st lactation non return at 56 days
	T4=C2	CI=days between 1st and 2nd calvings
	T5=IT	CI=days between 1st and 2nd calvings
IRL	T2=CY	CI=Calving interval
	T4=C2	CI=Calving interval
	T5=IT	CI=Calving interval
ISR	T3=C1	CR=Inverse of the number of insemination to conception (%)
	T4=C2	CR=Inverse of the number of insemination to conception (%)
ITA	T1=HC	NR= non-return rate 56 days (heifers)
	T2=CY	CF=Days to first service
	T3=C1	NR=Non-return rate at 56 days (%)
	T4=C2	FL=Interval from first to last insemination cows (days)
	T5=IT	DO=days open (days)
ITA(BSW)	T2=CY	CF=Interval calving to first insemination
	T4=C2	Days Open
	T5=IT	CI=Calving interval
NLD	T1=HC	CR=Heifers' Conception rate
	T2=CY	CF=Interval calving to first insemination (days)
	T3=C1	CR=Cows' Conception rate (binary trait) for cows
	T4=C2	FL=Interval from first to last insemination cows (days)
	T5=IT	CI=Calving Interval (days)
NOR	T1=HC	NR=NR=Non-return rate 56 days (heifers)
	T2=CY	CF=Interval calving to first insemination (days)
	T3=C1	NR=NR=Non-return rate 56 days (cows)
	T4=C2	CI=Calving Interval (days)
	T5=IT	CI=Calving Interval (days)
NZL	T2=CY	PM=Lactating cow's ability to start cycling
	T4=C2	PC=Lactating cow's ability to conceive (CR42)
	T5=IT	PC=Lactating cow's ability to conceive (CR42)
POL	T1=HC	CR=Conception rate for heifers

T2=CR Interval from calving to first insemination  
T3=C1 CR=Conception rate for cows  
T4=IT Days open  
T5=IT Days open

USA T1=HC CR=Conception rate (heifer)  
T2=CY CF=Interval from calving to first insemination  
T3=C1 CR=Conception rate (cow)  
T4=C2 DP=Daughter Pregnancy Rate  
T5=IT DP=Daughter Pregnancy Rate

ZAF T4=IT CI=Calving Interval  
T5=IT CI=Calving Interval

JPN T1=HC CR=Heifers' Conception rate  
T2=CY DO=Days open  
T3=C1 CR=Cows' Conception rate  
T4=C2 DO=Days open  
T5=IT DO=Days open

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CHANGES IN NATIONAL PROCEDURES  
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Changes in the national genetic evaluation of fertility traits are as follows:

CAN (HOL) Base change.  
DEU (HOL) Base change.  
FRA (HOL) Base change. Corrections in pedigree, as a consequence changes were observed in number of daughters and number of herds (bulls are not directly concerned). The several decreases in reliability are due to either a change in the information used to calculate EBVs of their parents (french EBV or MACE) or parents GEBVs or decrease in the reliability of their polygenic information (correction of database).  
GBR (HOL) Bulls' change of status due to new publication rules at the national level following the introduction of Single Step.  
GBR (HOL) Missing bulls due to genotypes checks or dams failing to pass parentage validation.  
ITA (HOL) Base change. Cut off one year. Excluded bulls which are not publishable in releasible list and do not belong to ITA.  
ITA (HOL) In pedigree loading excluded North America Partners bulls <2 years old.  
POL (HOL) Decrease in number of herds and daughters due to data edits caused decrease of EDC.

INTERBULL CHANGES COMPARED TO THE DECEMBER ROUTINE RUN  
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No changes in Interbull procedures

DATA AND METHOD OF ANALYSIS  
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Thirteen Holstein populations sent GEBV data for up to 38 traits, while classical EBVs for the same traits were used in the analyses. Young bull GEBVs from the GEBV providers have been converted to the scales of all countries participating in classical MACE. A bull will get a MACE EBV or a GMACE EBV but not both.  
From those thirteen countries, National GEBVs of bulls less than seven years of age and with no classical MACE proofs were included for the breeding value prediction with a further requirement of either a MACE-PA or a GMACE-PA (for young genomic bulls with young genomic sires) being available.

The parameter-space approach is used for the GMACE genetic evaluations (Sullivan, 2016)

SCIENTIFIC LITERATURE  
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The international genetic evaluation procedure is based on international work described in the following scientific publications:

Sullivan, P.G. 2016. Defining a Parameter Space for GMACE. Interbull Bulletin 50, p 85-93.

VanRaden, P.M. and Sullivan, P.G. 2010. International genomic evaluation methods for dairy cattle. Gen. Sel. Evol. 42:7

Sullivan, P.G. and Jakobsen, J.H. 2012. Robust GMACE for young bulls methodology. Interbull Bulletin 45, Article 1.

Sullivan, P.G. 2012a. GMACE reliability approximation. Report to the GMACE working group of Interbull. GMACE\_rels 2013

Sullivan, P.G. 2012b. GMACE variance estimation. Report to the GMACE working group of Interbull. GMACE\_vce 2013

Sullivan, P.G. 2012c. GMACE Weighting Factors. Report to the GMACE working group of Interbull. GMACE\_gedcs 2013

Jakobsen, J.H. and Sullivan, P.G. 2013. Trait specific computation of shared reference population. Reference sharing Nov 2013

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 NEXT ROUTINE INTERNATIONAL EVALUATION  
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Dates for next routine run can be found on <http://www.interbull.org/ib/servicecalendar>

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 NEXT TEST INTERNATIONAL EVALUATION  
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Dates for next routine run can be found on <http://www.interbull.org/ib/servicecalendar>

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 PUBLICATION OF INTERBULL ROUTINE RUN  
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Results were distributed by the Interbull Centre to designated representatives in each country. The international evaluation file comprised international proofs expressed on the base and unit of each country included in the analysis. Such records readily provide more information on bull performance in various countries, thereby minimising the need to resort to conversions.

At the same time, all recipients of Interbull results are expected to honour the agreed code of practice, decided by the Interbull Steering Committee, and only publish international evaluations on their own country scale. Evaluations expressed on another country scale are confidential and may only be used internally for research and review purposes.

Table 1. National evaluation dates in GMACE run April 2022

Country	Date
BEL	20201201
CAN	20220401
DEU	20220405
DFS	20220301
ESP	20220310
GBR	20220304
ITA	20220310
NLD	20220401
POL	20220228
FRA	20220406

Table 2.

Number of bulls in reference population for		hco
CAN	35996.0	
DEU	8634.0 41207.0	
DFS	4875.0 35306.0 36219.0	
FRA	3822.0 32322.0 31768.0 33879.0	
POL	4396.0 30319.0 30034.0 27834.0 31977.0	
NLD	3909.0 33914.0 33249.0 31800.0 29070.0 34963.0	
ITA	28638.0 6542.0 3624.0 3020.0 3123.0 3079.0 29325.0	

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 Number of bulls in reference population for      crc  
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BEL 1458.0  
CAN 704.0 35987.0  
DEU 723.0 9005.0 43819.0  
DFS 634.0 5055.0 37666.0 38628.0  
ESP 700.0 5956.0 38832.0 37814.0 39911.0  
GBR 671.0 32746.0 9438.0 5403.0 6397.0 35616.0  
ITA 692.0 31175.0 6840.0 3786.0 4291.0 30272.0 31908.0  
NLD 738.0 4110.0 36325.0 35685.0 36295.0 4465.0 3262.0 38037.0  
POL 820.0 4425.0 32746.0 32502.0 33082.0 4735.0 3211.0 31570.0 33816.0  
FRA 701.0 4047.0 34481.0 33938.0 34547.0 4126.0 3222.0 33982.0 30047.0 36148.0

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Number of bulls in reference population for ccl  
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CAN 39006.0  
DEU 8882.0 41655.0  
DFS 4919.0 35496.0 36370.0  
FRA 3927.0 32550.0 31955.0 34183.0  
GBR 32728.0 9295.0 5241.0 3999.0 34442.0  
ITA 31153.0 6725.0 3669.0 3120.0 30181.0 31846.0  
NLD 3994.0 34129.0 33430.0 31984.0 4245.0 3147.0 35275.0  
POL 4432.0 30555.0 30253.0 28080.0 4667.0 3158.0 29317.0 32126.0

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Number of bulls in reference population for cc2  
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BEL 1652.0  
CAN 727.0 41584.0  
DEU 728.0 9102.0 44029.0  
DFS 636.0 5117.0 37787.0 38757.0  
ESP 703.0 6026.0 38956.0 37940.0 40049.0  
GBR 687.0 35214.0 9522.0 5439.0 6440.0 38010.0  
ITA 706.0 32906.0 6867.0 3801.0 4309.0 31971.0 33640.0  
NLD 743.0 4199.0 36435.0 35793.0 36409.0 4513.0 3293.0 38363.0  
POL 992.0 4618.0 32860.0 32614.0 33196.0 4852.0 3291.0 31692.0 34513.0

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Number of bulls in reference population for int  
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BEL 1413.0  
CAN 579.0 39887.0  
DEU 723.0 9002.0 43858.0  
DFS 634.0 5071.0 37698.0 38660.0  
ESP 700.0 5974.0 38862.0 37851.0 39945.0  
GBR 671.0 35035.0 9471.0 5412.0 6409.0 37813.0  
ITA 571.0 31714.0 6822.0 3792.0 4293.0 31884.0 32435.0  
NLD 738.0 4134.0 36358.0 35721.0 36328.0 4491.0 3281.0 38219.0  
POL 762.0 4353.0 32772.0 32531.0 33107.0 4740.0 3142.0 31600.0 33765.0