```
INTRODUCTION
--------------------------------------------------------------------------------
The latest genomic routine international evaluation for females fertility traits took place
as scheduled at the Interbull Centre. Data from 18 countries were
included in this evaluation.

International genetic evaluations for female fertility traits of bulls from
Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany,
Ireland, Israel, Italy, Netherlands, New Zealand, Norway, Poland, Spain, Sweden,
Switzerland, South Africa, Japan, the United Kingdom  and the United States of America were computed.
Holstein data were included in this evaluation.

BEL, CAN, DEU, ESP, 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   Calving interval converted to 42 days pregnancy rate
         T4=C2   Calving interval converted to 42 days pregnancy rate
         T5=IT   Calving interval converted to 42 days pregnancy rate

BEL      T2=CY   PR=Pregnancy Rate (=[21/(DO-45+11)]*100, with DO=days open)
         T4=C2   PR=Pregnancy Rate (=[21/(DO-45+11)]*100, with DO=days open)
         T5=IT   PR=Pregnancy Rate (=[21/(DO-45+11)]*100, with DO=days open)

CAN      T1=HC   NR=Non Return Rate after 56 Days in heifers (NRR), %
```

```
         T2=CY   CF=Interval from Calving to First Service in cows(CF)
         T3=C1   NR=Non Return Rate after 56 Days in cows(NRR), %
         T4=C2   FC=Interval first insemination-conception in cows
         T5=IT   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
```

CHANGES IN NATIONAL PROCEDURES

Changes in the national genetic evaluation of fertility traits are as follows:

DEU HOL   -Introduced a mixed genomic reference population for German Holstein routine genomic evaluation
    -Base change

CAN HOL   -Base change

FRA HOL   -Base change

ITA HOL   -Base change

NLD HOL   -Changes in the conventional evaluation (see MACE doc)
INTERBULL CHANGES COMPARED TO THE DECEMBER ROUTINE RUN

No changes in Interbull procedures

DATA AND METHOD OF ANALYSIS

Eleven 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 eleven 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

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

NEXT ROUTINE INTERNATIONAL EVALUATION

Dates for next routine run can be found on http://www.interbull.org/ib/servicecalendar

NEXT TEST INTERNATIONAL EVALUATION

Dates for next routine run can be found on http://www.interbull.org/ib/servicecalendar

PUBLICATION OF INTERBULL ROUTINE RUN

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 2019

Country Date

BEL   20181201
CAN   20190401
DEU   20190402
DFS   20190305
ESP   20190318
GBR   20190305
ITA   20190311
NLD   20190401
POL   20190228
FRA   20190403
==

Table 2.

Number of bulls in reference population for   hco

```
CAN 31877.0
DEU  4015.0 35326.0
DFS  3238.0 32603.0 33717.0
FRA  3292.0 31129.0 30989.0 33156.0
POL  3554.0 28261.0 28399.0 27109.0 30320.0
NLD  3238.0 32282.0 32124.0 31011.0 27964.0 33606.0
ITA 26200.0  3443.0  2552.0  2618.0  2846.0  2555.0 26747.0

-------------------------------------------------------
Number of bulls in reference population for        crc
-------------------------------------------------------
BEL  2479.0
CAN  1467.0 31743.0
DEU  1154.0  4142.0 37400.0
DFS   993.0  3313.0 34616.0 35774.0
ESP  1119.0  3537.0 35057.0 35064.0 36187.0
GBR  1094.0 28587.0  4185.0  3400.0  3625.0 30138.0
ITA  1395.0 28595.0  3550.0  2616.0  2802.0 27323.0 29154.0
NLD  1110.0  3330.0 34306.0 34186.0 34640.0  3452.0  2647.0 36280.0
POL  1273.0  3490.0 30351.0 30525.0 30858.0  3283.0  2826.0 30090.0 31829.0
FRA  1144.0  3427.0 32934.0 32820.0 33308.0  3474.0  2740.0 32860.0 28983.0 35038.0

-------------------------------------------------------
Number of bulls in reference population for        cc1
-------------------------------------------------------
CAN 34661.0
DEU  4093.0 35515.0
DFS  3245.0 32729.0 33786.0
FRA  3370.0 31268.0 31065.0 33258.0
GBR 28444.0  4146.0  3335.0  3421.0 29339.0
ITA 28629.0  3517.0  2578.0  2711.0 27307.0 29183.0
NLD  3278.0 32410.0 32195.0 31092.0  3322.0  2608.0 33788.0
POL  3578.0 28453.0 28558.0 27277.0  3310.0  2877.0 28129.0 30486.0

-------------------------------------------------------
Number of bulls in reference population for        cc2
-------------------------------------------------------
BEL  2928.0
CAN  1617.0 37007.0
DEU  1175.0  4183.0 37514.0
DFS  1003.0  3353.0 34710.0 35852.0
ESP  1135.0  3580.0 35153.0 35137.0 36271.0
GBR  1188.0 30780.0  4207.0  3417.0  3645.0 32359.0
ITA  1507.0 30414.0  3563.0  2627.0  2815.0 29099.0 30974.0
NLD  1138.0  3388.0 34397.0 34242.0 34700.0  3465.0  2674.0 36537.0
POL  1637.0  3670.0 30444.0 30604.0 30939.0  3374.0  2927.0 30187.0 32543.0

-------------------------------------------------------
Number of bulls in reference population for        int
-------------------------------------------------------
BEL  2068.0
CAN  1046.0 35239.0
DEU  1140.0  4125.0 37410.0
DFS   993.0  3318.0 34646.0 35778.0
ESP  1115.0  3536.0 35083.0 35065.0 36186.0
GBR  1093.0 30629.0  4187.0  3401.0  3626.0 32208.0
ITA   987.0 29099.0  3536.0  2623.0  2806.0 29006.0 29655.0
NLD  1106.0  3327.0 34330.0 34174.0 34622.0  3448.0  2663.0 36400.0
POL  1188.0  3199.0 30373.0 30533.0 30861.0  3275.0  2563.0 30098.0 31551.0
```