

Interbull Centre Activity Report

January - December 2022



INTERBULL CENTRE

ACTIVITY REPORT 2022

INTERBULL CENTRE

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Swedish University of
Agricultural Sciences

The Interbull Centre is the operational unit of ICAR's permanent sub-committee Interbull and Interbeef Working Group.



The Interbull Centre holds the status of European Union Reference Centre (EURC) for Bovine Breeding.



Interbull Centre services are provided under the controls established by a Bureau Veritas Certification approved management system that conforms with ISO 9001:2015. Bureau Veritas Certification Certificate Number N° SE008278-1





INTERBULL CENTRE ACTIVITY REPORT 2022

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inter  **genomics**

GEN  **EX**
International Genotype Exchange Platform

The Interbull Centre is a section of the Department of Animal Breeding and Genetics (HGEN) of the Swedish University of Agricultural Sciences (SLU). The Interbull Centre is the operational unit for Interbull and Interbeef, a permanent subcommittee and a working group of the International Committee for Animal Recording (ICAR), respectively, and operates as the European Union Reference Centre for Zootechnics (Bovine Breeding). This Report describes the Interbull Centre activities in 2022.

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FOREWORD

2022 was yet another challenging year for our whole international community as we got emerged from the Covid-19 Pandemic. We were able to meet – for the first time since 2019 in Cincinnati – face-to-face during an ICAR/Interbull Meeting in Montreal. It was a pleasure catching up with our old friends and making new ones! We thank the organisers in Montreal for the hard work they put in to create such a great event, and to also provide online presence to those of us who could not be present in Canada.

The attendance at the Interbull Business Meeting was especially appreciated, as we could present the outcomes of the Interbull Governance Review, as well as the progress on the Review's recommendations. It was also a time to hear from our service users and we look forward to doing so again in Lyon in August 2023.

In 2022, the Interbull Steering Committee welcomed one new member, Laurent Journaux as we said goodbye to long-term member Sophie Mattalia. Gerrit Kistemaker stepped down from the Interbull Technical Committee after 23 years of contribution. Gerrit was one of the original members of the ITC when it was established in 1999. In addition, the Scientific Advisory Committee was disbanded after the Governance Review and we would like to express our sincere thanks to Ignacy Misztal, Michael Goddard and Daniel Gianola for their great contributions to our shared journey.

The Interbull Centre continued to build on the activities that were started in recent years:

- The team at the Interbull Centre delivered all scheduled services at the highest level of quality, according to schedule;
- The Key Goals listed in the Interbull 2020-2023 Strategic plan continue to be leading in our Annual Operating Plans, and the activities reported in this 2022 Activity Report;
- The 2022 Annual Operating Plan was written – using the 2022-2023 Strategic Plan as a guide, and building on the experience of our first, 2021, Annual Operating Plan.

This report covers the calendar year 2022 and we would like to express our sincere thanks to the Interbull Centre Team, and all Committees, Working Groups, Task Forces, organisations and other individuals who continue to contribute to the successes of Interbull, Interbeef, GenoEx and the EU Reference Centre throughout the year.

Warm Regards,

Matthew Shaffer,

Chair, Interbull Steering Committee

Toine Roozen,

Interbull Centre Director

1. PEOPLE

1.1. Interbull Centre Personnel

Interbull Centre staff are employed by the Department of Animal Breeding and Genetics (HGEN) of the Swedish University of Agricultural Sciences (SLU). At the end of 2022, the team consisted of the following members of staff:

- Toine Roozen (MSc, MBA) – Director
- Valentina Palucci (MSc) – Service and Quality Manager

Genetic Data Analyst (*Genetics*):

- Joanna Sendeka (PhD)
- Fernando Macedo (PhD)
- Katrine Haugaard (PhD)

Genetic Data Analyst (*Information Technology*):

- Marcus Pedersén - Systems Administrator, IT Coordinator
- Carl Wasserman - Systems Developer
- Jan-Erik Strömquist - Programmer

In addition, the following SLU member of staff has part-time responsibilities at the Interbull Centre:

- Cano Merkan - IT Coordinator / Systems Analyst

Staff changes in 2022

Hans Persson, programmer within the Interbull Centre IT group, left his position at the Centre in June 2022 after almost five years. Hans has extensively worked on further improving the GenoEx platform, both PSE and GDE databases. We kindly thank him for his time and competences shared within the team and wish him all the best in his future career.

After working more than 3 years at the Interbull Centre, **Simone Savoia** (PhD, R&D Manager) left the Interbull Centre at the end of August 2022. Simone contributed a lot on the improvement of InterGenomics services and has been a great addition to the team. We warmly thank him for his time and wish him all the best in his future career.

Sofie Lennartsson was part-time administrator for Interbull Centre from December 2020 until August 2022. We thank Sofie for her help during her time working with us and we wish her good luck for the future.

1.2. Committee, Working Group and Task Force membership

Interbull Centre personnel are members of various Interbull and Interbeef Committees, Task Forces and Working Groups. Details of these groups are included in Appendix 1.

1.3. Training, Courses, Meetings and Conferences

Interbull Centre staff is involved with many courses, meetings and conferences. Attendance details are provided in Appendix 2.

1.4. Consultants and Suppliers

The Interbull Centre continues to collaborate with experts in different time zones:

- **Pete Sullivan** (Lactanet, Canada): works as a part time consultant. During 2022, Pete’s activities were related to supporting GMACE and MT-EDC software, and Key contributions to the “Genomic Pre-selection and Future MACE” (§9.3) and “Validation” (§4.1 and §9.5) Working Groups.
- **Thierry Pabiou** (ICBF, Ireland): supplies international genetic parameters for Adjusted Weaning Weight (AWW) and Carcass traits (CARC) for Interbeef evaluations (§5.0, §10.1 and §12.1) to the Interbull Centre.
- **Zdenka Vezela** (CMBC, Czech Republic): supplies international genetic parameters for calving traits (birth weight, calving ease) for Interbeef evaluations (§5.0) to the Interbull Centre.
- **Chris Murphy** (Chris Murphy Advisory PTY Ltd, Australia): Follow up to the 2021 Interbull Governance Review, and carrying out the 2022 “Interbull Service Users Survey” (§3.5).
- **Pär Herrman** (Bureau Veritas Certification Sverige AB, Sweden): Appointed as Interbull Centre’s external auditor for the ISO 9001 standard for the whole second re-certification period. Pär visited the Interbull Centre on 8 November 2022 to perform his first surveillance audit for the new re-certification period (§3.2).

2. GOVERNANCE

2.1. Interbull Governance Review

During the latter part of 2021, a review of governance activities was carried out by an independent consultant, Chris Murphy. The purpose of the review was to identify any gaps or areas for improvement to make governance processes more effective, improve the interaction and effectiveness of governance structures, and enhance governance-related relationships.

Matthew Shaffer and Toine Roozen shared the outcomes of the review with the ICAR Board during its meeting on 22 February 2022. Chris Murphy and Matthew Shaffer reported to the wider Interbull Community during the Business Meeting in Montreal on the Governance Review, and the progress with following up on its recommendations respectively. A summary of the Interbull Governance Review is available online¹.

The governance review contributed to the following topics that were implemented in 2022:

1. The Interbull SC **Terms of Reference**² were updated, with the inclusion of term limits, and a clarification of how countries using Interbull services can be represented by a SC member.
2. The **Scientific Advisory Committee** was disbanded with a view to access specific scientific expertise on an “as needs” basis. We like to thank once again all SAC members for their contributions through many years: Georgios Banos (until 2012), Larry Schaeffer (until 2013), Vincent Ducrocq (until 2019), Daniel Gianola, Michael Goddard and Ignacy Misztal.
3. The process to further clarify the mandate, scope and objectives of the **Interbull Technical Committee** has been initiated.
4. A **publishing schedule** is in place for Annual Operating Plan (January), Annual Reports (March), Executive Summaries (March, June, September and December).

The Interbull SC continues to address remaining recommendation to:

- Improve the speed, clarity, and transparency of decision-making processes
- Better define and streamline the relationships between Interbull and other committees and stakeholders.

2.2. Interbull Steering Committee (SC)

Sophie Mattalia ended her 16-year Interbull SC membership; We thank Sophie for her dedication during the 16 years on the Interbull SC.

During the Interbull Business Meeting on 31 May 2022, **Matthew Shaffer** and **Laurent Journaux** were proposed as Interbull Steering committee members, and subsequently endorsed by the ICAR Board during its meeting on 1 June 2022. **Matthew Shaffer** is an Interbull SC member since 2016, representing Oceania. Matthew is also the current Chair of the Interbull Steering Committee. **Laurent Journaux**, from France Génétique Elevage, was previously on the ICAR board and represents France and Wallonia on the Interbull SC.

Matthew **Shaffer** and Brian **Van Doormaal** are the sitting Chair and Vice-Chair of the Interbull SC with terms as Chair and Vice-Chair until the 2023 Annual Meeting.

¹ <https://interbull.org/ib/itbcreports>

² <https://interbull.org/ib/termsofreference>

Table 2.1: Interbull Steering Committee membership and terms (December 2022).

Name	Representing	End of term
Gert Pedersen Aamand	Denmark, Finland, Sweden & Norway	2023
Urs Schnyder	Germany, Austria & Switzerland	2023
Gerben de Jong	UK, Netherlands & Ireland	2023
Daniele Vicario	Italy, Spain & Portugal	2024
Brian Van Doormaal	North America	2024
Marija Klopčič	Central & Eastern Europe	2025
Ezequiel Nicolazzi	North America	2025
Matthew Shaffer	Australia & New Zealand	2026
Laurent Journaux	France & Wallonia	2026

2.3. Interbull Technical Committee (ITC)

The composition of the Interbull Technical Committee has remained very stable for many years. In December 2022, **Gerrit Kistemaker**, one of the original members of the ITC when it was established in 1999, stepped down as member of the Interbull Technical Committee. We thank Gerrit for his many contributions over the last two decades.

As a follow up to the 2021 Governance Review, the process for appointing ITC members is under review, and an immediate addition to the ITC is therefore not yet foreseen.

The Interbull Technical Committee held its first **Strategic Technical Meeting** in Montreal, in conjunction with the ICAR-Interbull meeting; the committee identified and discussed technical challenges on the way to meet the requirements 2-5-10 years ahead and the committee's tasks to fulfil the Interbull mission via technical solutions. The main topics identified and discussed were reported at the Interbull Business Meeting, and included:

1. Validation methods under genomic for national evaluations.
2. Genomic pre-selection: Impact on national and International evaluations.
3. *"Which outputs for which users?"*

The first two of these topics are addressed by the relative working groups. Regarding the third point, the following issues/needs were identified:

- More near-time data/evaluation results exchange to fulfil NGECS' needs;
- Simplify national providers' requirements;
- New services;
- Advertising further the infrastructure available at the Interbull Centre for sharing and exchanging of genotypes as this remain an important factor for countries.

The Interbull Technical Committee will continue working finding suitable technical solution to such issues/needs.

2.4. Business Funding Models Task Force (BFMTF)

The main task of the BFMTF, appointed by the Interbull SC in 2019, is to assess options and make recommendations on funding models for services offered by the Interbull Centre. At the start of 2022, the focus of the BFMTF was on the Business Rules and Options around the potential delivery of SNP Mace (see §9.1). In the latter part of 2022, the BFMTF's focus has been towards alternative funding models for Interbull MACE services, and for a fee structure for Exchange Services at the Interbull Centre. The outcomes of these activities will be reported during the 2023 Interbull Business Meeting.

2.5. New Traits Pipeline Working Group (NTP WG)

The objectives and activities of the Interbull SC-appointed NTP WG are in line with Key Goal 2 of the Interbull 2020-2023 Strategic Plan. The NTP WG's framework to guide in the decision process for introducing new traits and services in Interbull Centre portfolio (as developed during 2021) was presented during the online webinar held on March 2022 together with the launch of the PREP database (see §7.2), which represents the main hub around which the new NTP framework has been built.

Preliminary results of the information pertinent to potential new traits to add to the international evaluations offered by Interbull were also presented during the 2022 Interbull Annual Meeting in Montreal, Canada.

The **PREP database** is open for collecting information on a wide range of traits and breeds – even those not (yet) included in international evaluations.

Organisations have the possibility of sharing (basic) information on traits recorded (and possibly evaluated) at national levels and show their potential interest in including these traits in international evaluations.

2.6. Codes of Practice

Together with the relevant communities, Interbull Centre staff have developed and maintained 'Codes of Practice' which guide the Interbull Centre and its Service Users in an efficient implementation and delivery of services.

Interbull Code of Practice

The Interbull Code of Practice³ is updated on the basis of decisions by the Steering Committee. No notable updates were carried out in 2022.

Interbeef Code of Practice

The Interbeef Code of Practice, available through the ICAR website⁴, was updated in 2022, based on decisions from the Interbeef Working group, notably:

- Chapter 10, Service fee: better description of how the service fee is calculated.

Together with the Interbeef Code of Practice, the "Interbeef Guidelines" provide useful information for new Organisations interested in joining Interbeef Service regarding the necessary actions and relevant files required. Both documents are available on the Interbeef page on the ICAR website⁴, selecting "File and formats for the Interbeef international genetic evaluations".

GenoEx-PSE Code of Practice

No changes were applied to the GenoEx-PSE Code of Practice⁵ during 2022.

2.7. ICAR Guidelines

Interbull Guidelines (ICAR Guidelines Section 09)

The "Interbull Guidelines" (ICAR Guidelines' "Section 09 – Dairy Cattle Genetic Evaluation") were further reviewed during 2022 adding more recent information regarding genomic evaluations and latest recommendations from trait harmonisation. The latest version of the guidelines is available on the ICAR website⁶.

³ <http://www.interbull.org/ib/codeofpractice>

⁴ <https://www.icar.org/index.php/technical-bodies/working-groups/interbeef-working-group/>

⁵ https://interbull.org/ib/pse_cop

⁶ <https://www.icar.org/index.php/icar-recording-guidelines/>

3. SERVICES & OPERATIONS – Interbull Centre

Since the start of international evaluations in 1995, the service portfolio and output at the Interbull Centre has increased significantly; both through expansion of the international genetic evaluations to include new populations and new traits, and through the addition of new services.

GenoEx-GDE, for genotype data exchange, has been in use for the sharing of genotypes for the InterGenomics-Brown Swiss evaluations since 2021; In December 2022 it was put in use for the pooling of genotypes by InterGenomics-Holstein participants, in preparation for being officially introduced with the January 2023 InterGenomics-Holstein evaluation.

3.1. Global Reach

The Interbull Centre provides international genetic evaluation services for dairy and beef cattle in 34 countries from 5 continents; Europe: 26 countries; America's: 3; Oceania and Asia 2 each; Africa: 1.

Figure 3.1: Interbull's Global Reach (December 2022)



Dairy Evaluations:

Asia: Japan, South Korea

Africa: South Africa

America's: Canada, Uruguay, USA

Oceania: Australia, New Zealand

Europe: Austria, Belgium, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Ireland, Israel, Italy, Latvia, Lithuania, Luxemburg, The Netherlands, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, United Kingdom

Beef Evaluations:

Europe: Czech Republic, Denmark, Estonia, Finland, France, Germany, Ireland, Italy, Latvia, Slovenia, Sweden, Switzerland, United Kingdom

Oceania: Australia

GenoEx-PSE:

Europe: Denmark, Finland, Sweden, Germany, Austria, Luxemburg, Italy, Slovenia, Ireland, Norway, Poland, The Netherlands

Asia: Japan

3.2. Quality Management

The Interbull Centre gained ISO 9001 certification in 2016. All external audits to date have been concluded with total absence of non-conformities found. We are keen to keep these excellent results also for the next certification period by periodical review of our procedures and by keeping high focus towards our customers' satisfaction.

No additional services have been included in our Quality Management System since the inclusion of GenoEx-PSE and ICAR DNA Data Interpretation Centre Accreditation in 2020.

The services included in the ISO 9001 Management system are: MACE, GMACE, Interbeef, GenoEx-PSE and ICAR DNA Data Interpretation Centre Accreditation.

During the internal audits in August 2022, Management, Communication, Improvement tools, Personnel, Purchase and IT processes were reviewed by Valentina Palucci, Interbull Centre Quality Manager and certified ISO 9001 lead auditor.

The external audit on 8 November 2022 was the first surveillance audit of the second re-certification period. The surveillance audit was conducted by Bureau Veritas' Pär Herrman, who will accompany us during the current three-year period. The external audit went successfully with no non-conformities found.









3.3. Interbull Centre Annual Operating Plan

The six Key Goals shown in Figure 3.2 were identified in the Interbull 2020-2023 Strategic plan⁷ that resulted from the January 2020 Interbull Strategic Planning meeting.

These Key Goals form the basis of the **Interbull Centre Annual Operating Plan**, which includes Interbull Centre's planned Service and R&D activities for Interbull, Interbeef, EU Reference Centre, and ICAR. The latest Annual Operating Plan (2023) is available on the Interbull website⁸.

Figure 3.2: Key Goals in Interbull 2020-2023 Strategic Plan.

	Meeting future data service needs		Continuously improve core services
	Defining a new traits pipeline		Strengthening governance
	Providing international evaluations in the genomic era		Driving branding and marketing

3.4. Service Calendars

Schedules for International dairy and beef evaluations at the Interbull Centre are released upon approval by the Interbull Steering Committee and the Interbeef Working Group respectively. The Service Calendars are scheduled well in advance so that national genetic evaluation centres and the Interbull Centre can plan their activities accordingly. The latest service calendars are available online:

- Interbull service calendar⁹;
- Interbeef service calendar¹⁰.

⁷ <https://interbull.org/ib/itbcreports>

⁸ <https://interbull.org/ib/itbcreports>

⁹ <http://www.interbull.org/ib/servicecalendar>

¹⁰ <http://www.icar.org/index.php/technical-bodies/working-groups/interbeef-working-group>

3.5. Service Users Survey

One of the objectives within Key Goal 6 of the Interbull Strategic Plan 2020-2023 “Driving Branding and Marketing”, was to “**Clearly define Interbull’s value proposition**”.

Working towards this objective, Interbull worked with Chris Murphy Advisory, initiating a survey in November 2022. The survey sought the views of Service Users on the **benefits and value of existing services** offered by the Interbull Centre, including International Evaluations – MACE, GMACE, InterGenomics and Interbeef –, Validation services, and Data Exchange (e.g. parentage SNP data, genomic data, genetic recessive traits).

The survey was completed in early 2023. The information gathered through the survey will be used for:

- Communication and marketing
- Setting service fees
- Evaluating delivery of future services, and
- Offering current and new services to organisations that may not be involved with Interbull yet.

4. INTERNATIONAL DAIRY BREED EVALUATIONS - INTERBULL

4.1. Validation of National EBVs and GEBVs

Validation of national EBVs and GEBVs remains one of the top priorities towards reliable National and International, genetic and genomic evaluations. The portfolio of validation methods offered by Interbull consists of five (5) different validation methods:



- four methods aimed at assessing the quality of conventional national evaluations, namely Trend Validation Tests (Methods I, II, III) and Mendelian Sampling Variance test, and
- one assessing the quality of genomic national evaluations; GEBVtest.

The Interbull Validation Working Group created an enhanced version of the GEBVtest which can perform a more accurate comparison of the input data. The preliminary beta version of the program has been shared with the members of the Working Group and the Interbull Technical Committee for preliminary testing and will be presented during the 2023 Interbull Technical Workshop. Once introduced, the new software is expected to contribute to an increase in the accuracy of the validation procedures performed by the Interbull Centre.

4.2. MACE Evaluations

MACE Routine evaluations were performed in April, August and December 2022. MACE Test evaluations were performed in January-February 2022 and September-October 2022. Tables 4.1 and 4.2 show statistics on Interbull MACE evaluations.

Table 4.1: Size of the Interbull Centre operations for MACE

Multiple Across Country Evaluation (MACE)	Dec 2019	Dec 2020	Dec 2021	Dec 2022
Countries	33	33	33	33
Evaluation breeds	6	6	6	6
Country-breed-trait combinations	1 930	1961	1985	1985
Breed-trait evaluations	181	181	184	184
Animals in the pedigree database	36 094 659	38 286 074	46 224 599	48 102 774
Submitted national estimated breeding values	13 420 740	13 907 511	14 204 345	14 521 600
Qualified national estimated breeding values	7 332 267	7 518 415	7 642 967	7 845 907
Calculated international estimated breeding values	305 068 667	312 433 664	325 106 802	332 245 627
Distributed international estimated breeding values	112 896 290	114 804 143	117 662 597	119 484 986

Multiple Across Country Evaluation (MACE)	Sept 2019	Sept 2020	Sept 2021	Sep 2022
Estimated across country genetic correlations	12 894	13 043	13 452	13 432
Validation tests*: Trend Validation Tests (Methods I, II, III); Mendelian Sampling Variance Test; GEBVtest	233	252	345	443

* Subject to natural fluctuations

Many changes in national and international evaluations were introduced in 2022. All such changes are described in the service reports published on the Interbull Centre website, under MACE service reports¹¹, after each subsequent routine evaluation.

¹¹ http://www.interbull.org/ib/maceev_archive

Table 4.2: Degree of Participation to MACE evaluations as for April 2022

	Prod (3)	Conf (up to 33)	Udder (2)	Long (1)	Calv (4)	Fert (5)	Work (2)	SNP Training (1)	Total (50)	2204r vs 2104r
BSW	11	9	10	9	6	10	7	2	64	0 ⁽⁺⁾
GUE	5	4	5	4	-	5	-	-	23	-1 ⁽⁻⁾
HOL	29	23	29	21	18	21	15	6	162	+1 ⁽⁺⁾
JER	12	10	10	9	-	9	6	2	58	0
RDC	15	10	14	12	7	11	7	-	76	0
SIM	12	-	11	5	-	-	-	-	28	0
Tot	84	56	79	60	31	54	35	10	411	
Change	0	0	0	-2*	0	+2**	0	0		0

Routine international genetic evaluations for Brown Swiss, Guernsey, Holstein, Jersey, Red Dairy Cattle and Simmental were computed as scheduled in April, August and December 2022. The following changes in participation occurred during the April 2022 Routine evaluations:

* LONGEVITY: NZL stopped participating in the evaluation for BSW⁽⁻⁾ and GUE⁽⁻⁾ due to reductions in EDC.

** FERTILITY: SVN joined the evaluation for interval traits (INT) for the first time with HOL⁽⁺⁾ and BSW⁽⁺⁾ data.

4.3. Truncated MACE (“TMACE”)

National genomic evaluations are increasingly dependent on Interbull MACE results due to the inclusion of foreign genotypes without national phenotypic information in the reference population. The only source of phenotypic information available for such animals are de-regressed MACE EBVs on the scale of interest. The latest MACE EBVs are used for regular estimation of SNP effects. However, obtaining appropriate MACE de-regressed values for validation purposes is not a straightforward task. In order to assist countries with improving the national genomic prediction and validation, Interbull introduced Truncated MACE as an additional service. Truncated MACE is performed annually in October. The TMACE evaluations performed in October 2022 with current reduced data provided by the country-breeds-traits are identified in Table 4.3.

Table 4.3: Country-breed-trait combinations in the October 2022 TMACE evaluation

Country	Breed	Trait	Organisation
DEA ⁺	BSW	All	LFL & ZuchtData
USA	HOL JER BSW GUE RDC	All	CDCB
JPN	HOL	All	NLBC
CAN	HOL JER BSW GUE RDC CAM	All	Lactanet
CHE	HOL BSW SIM	All	Qualitas

+ DEA: Germany and Austria

4.4. International Genomic Evaluation of Young Bulls (GMACE)

International genomic evaluations of young bulls (GMACE) are, to date, conducted for the Holstein breed only: 13 countries submit national genomic breeding value estimates (GEBV) for up to 38 traits. Statistics on GMACE evaluations are presented in Table 4.4.

GMACE Test evaluations were performed as scheduled in January-February 2022 and September-October 2022. GMACE Routine evaluations were performed in April, August and December 2022.

Table 4.4 - Size of the Interbull Centre operations for GMACE

Genomic Multiple Across Country Evaluation (GMACE)	Dec 2019	Dec 2020	Dec 2021	Dec 2022
Countries	33	33	33	33
Evaluation breeds	1	1	1	1
Country-breed-trait combinations	376	399	388 ⁺	388 ⁺
Breed-trait evaluations	38	38	38	38
Animals in the pedigree database	36 094 659	38 286 074	46 224 599	48 102 774
Submitted national estimated breeding values	29 266 198	32 020 628	34 518 839	35 779 884
Qualified national estimated breeding values	19 527 768	20 240 812	20 761 359	19 927 617
Calculated international estimated breeding values	175 338 148	185 107 347	193 663 067	179 195 268
Distributed international estimated breeding values	427 365	410 872	406 726 ⁺	403 026

+ A mismatch between MACE and GMACE based definition and direction of scale caused some country-breed-trait combinations to be excluded from the December 2021 and 2022 evaluations.

4.5. InterGenomics

Interbull Centre conducts international genomic evaluations of Brown Swiss dairy cattle populations (“InterGenomics-BSW”), and (small) Holstein populations (“InterGenomics-Holstein”). Statistics on these evaluations are presented in Tables 4.5 and 4.6.

During 2022, the application of the Interbull Genomic Reliabilities method was tested for the InterGenomics (BSW) evaluation process in order to have both workflows (BSW and HOL) aligned. The workflow for InterGenomics-Holstein was further streamlined carrying out all preparation steps for the participating countries to upload their genotypes data via GenoEx-GDE, and additional information - like a bull’s AI status- via the “AnimInfo” module within the Interbull Data Exchange Area (“IDEA”). All improvements will be introduced into the service in 2023.

Table 4.5: Size of the Interbull Centre operations for InterGenomics (BSW & HOL)

InterGenomics	Dec 2019	Dec 2020	Dec 2021	Dec 2022
Countries	8	13+3*	12+1*	12+1*
Breeds	1	2	2	2
Breed-Country-trait combinations	280	369	375	377
Unique submitted genotypes	44 625	86 043	101 589	111 850
Genotypes entering imputation & genomic evaluation	36 791	53 945	59 156	64 289
Distributed international genomic estimated breeding values	10 301 760	12 442 915	13 785 838	15 124 006

InterGenomics-Brown Swiss countries: Canada, France, Germany, Austria, Italy, Slovenia, Switzerland, USA

InterGenomics-Holstein countries: (Portugal), Ireland, Israel, Slovenia, South Korea

* Original contributing countries for InterGenomics-Holstein (2020): France, DFS, Germany

Ongoing contributing country: Germany



5. INTERNATIONAL BEEF EVALUATIONS - INTERBEEF

Interbeef routine evaluations were performed, as scheduled, in January and October 2022, and included 12 countries. The distribution of Interbeef results across breeds, traits and countries, is reported in Table 5.1.



Table 5.1: Distribution of Interbeef evaluation across breeds, traits and countries

	Adjusted Weaning Weight					Birth Weight					Calving Ease					Total
	AAN	CHA	HER	LIM	SIM	AAN	CHA	HER	LIM	SIM	AAN	CHA	HER	LIM	SIM	
Australia		✓		✓												2
Czech Republic	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	15
DFS*	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	15
Estonia	✓	✓	✓	✓							✓	✓	✓	✓		8
France		✓		✓			✓		✓			✓		✓		6
Germany	✓	✓	✓	✓	✓											5
Great Britain				✓					✓					✓		3
Ireland	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	15
Italy		✓		✓												2
Latvia		✓		✓												2
Slovenia		✓		✓			✓		✓			✓		✓		6
Switzerland	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	15
Total per breed	6	11	6	12	5	4	6	4	7	4	5	7	5	8	4	94

+ DFS: Denmark, Finland and Sweden

Statistics on the Interbeef evaluations of the beef breeds Aberdeen Angus, Charolais, Hereford, Limousin, and Simmental are presented in Table 5.2.

Table 5.2: Size of the Interbull Centre operations for Interbeef

Interbeef	Oct 2019	Oct 2020	Oct 2021	Oct 2022
Countries	9	11	13	12
Evaluation breeds	5	5	5	5
Country-breed-trait combinations	57	64	86	94
Animals in the pedigree database	35 955 367	38 205 169	46 144 424	48 064 957
Submitted phenotype records	41 913 269	43 435 328	45 636 686	50 616 474
International estimated breeding values*	263 155 545	330 541 516	396 706 011	493 903 871
Publishable international estimated breeding values*	7 353 808	7 696 416	8 808 232	9 803 556

* Direct + maternal EBVs are counted as one.

Interbeef breeding values are estimated using MiX99 Software. Reliabilities are calculated using the MTEDC5 package. Variance components for Adjusted Weaning Weight (aww) are estimated by ICBF (Ireland) using the DMU package, while variance components for the calving traits Birth Weight (bwt) and Calving Ease (cae) are estimated by CMBC (Czech Republic) using the BLUPF90 package.

5.1. Changes in participation

At the start of 2022, South Africa withdrew from the evaluations of Interbeef. During 2022, TYR (Norway) expressed interest in joining Interbeef services during 2023.

Switzerland joined the evaluation for calving traits for all breeds (Aberdeen Angus, Charolais, Hereford, Limousin and Simmental).

6. DATA EXCHANGE SERVICES

The Interbull Centre provides three levels of genetic and genomic data exchange:

1. Parentage SNP Data
2. (Large) Genotype Data
3. Genetic Recessive Trait Information

Participation for each of these services (December 2022) is provided in Table 6.1.

Table 6.1: Participation in genetic and genomic data exchange services (December 2022)

Country	Organisation	Parentage SNP	Genotypes	Recessive Traits
Australia	DataGene			✓
Belgium	Service Public de Wallonie			✓
Canada	Lactanet		✓	✓
DFS*	SEGES/NAV	✓		✓
France	GenEval		✓	
Germany	Vit	✓		✓
	LFL		✓	
Great Britain	AHDB			✓
Ireland	ICBF	✓	✓	
Israel	ICBA		✓	
Italy	ANAPRI	✓		
	ANARB		✓	
	ANAFIBJ	✓		
Japan	LIA	✓		
Netherlands	CRV	✓		✓
Norway	GENO	✓		
Poland	NRIAP	✓		
Slovenia	AIS	✓	✓	
South Korea	NIAS		✓	
Switzerland	Qualitas		✓	✓

+ DFS: Denmark, Finland, Sweden

6.1. Parentage SNP Exchange

The International Genotype Exchange Platform (“GenoEx”) is a platform for exchanging genotypes in a standardised way. On 1 June 2018, GenoEx-PSE (Parentage SNP Exchange) was the first service to be launched on the Interbull Centre’s International Genotype Exchange Platform.

Data Exchanged	Service/Database	Purpose	Key Benefits include
Parentage SNP	GenoEx-PSE	Facilitate and streamline parentage analysis activities carried out by organisations that are responsible and/or active in parentage integrity.	All bull owners have more accurate identities of daughters in semen importing countries. Available for any breed (dairy & beef)

Table 6.2: Upload of Parentage SNP data to GenoEx-PSE, sorted by Number of Organisations x Breed (December 2022).

Breed	Females	Males	Total	Organisations
Holstein	9 734	30 930	40 664	7
Red Dairy Cattle	54	48 415	48 469	4
Simmental		889	889	3
Jersey		679	679	3
Meuse Rhine Yssel		180	180	3
Holstein, Red and White	41	69	110	3
Brown Swiss	5 446	773	6 219	2
Charolais		344	344	2
Belgian Blue		274	274	2
Angus		260	260	2
Limousin		247	247	2
Hereford		117	117	2
Dutch Frisian		79	79	2
Blonde d'Aquitaine		56	56	2
Salers		56	56	2
Parthenaise		42	42	2
Piedmont		33	33	2
Wagyu		16	16	2
Dexter		15	15	2
Highland Cattle		4	4	2
Dairy Shorthorn		84	84	1
Uckermärker		51	51	1
British Frisian		50	50	1
Aubrac		46	46	1
Montbeliard		45	45	1
Normandy		11	11	1
Kerry		4	4	1
Pinzgau		4	4	1
Galloway		3	3	1
Romagnola		3	3	1
Rouge des Pres		2	2	1
Belgium Red & White		1	1	1
Crossbreed		1	1	1
Gelbvieh		1	1	1
Glan Donnersberg		1	1	1
Murray-Grey		1	1	1
TOTAL			99 061	



The main purpose of GenoEx-PSE is to provide a service for exchanging standardised sets of SNP for genotyped animals **to facilitate and streamline parentage analysis activities** carried out by organisations that are responsible and/or active in parentage integrity.

One of the key benefits of joining GenoEx-PSE is that AI bull owners will have more accurate identity of daughters in countries importing semen. GenoEx-PSE is also expected to assist with the transition from the use of microsatellites to the use of SNP for parentage verification.

ICAR accreditation for DNA data interpretation (§8.1) is an important prerequisite for participation in the PSE service. Further details are available on the GenoEx website¹².

6.2. Genotype Data Exchange

Within the International Genotype Exchange Platform (GenoEx), the Genomic Data Exchange database (GenoEx-GDE) provides an easy way for exchanging large genotype datasets, facilitating building reference populations, decreasing costs by avoiding re-genotyping the same individuals and encouraging development of genomic evaluations. GenoEx-GDE was launched in August 2020, and have been used routinely to provide genotypes for the InterGenomics BSW service since January 2021.

Data Exchanged	Service/Database	Purpose	Key Benefits include
Genotypes	GenoEx-GDE	Facilitate and streamline (large) genotype data exchange, through standardised procedures and file formats, allowing definition of specific sharing permission.	Countries with national genomic evaluations are able to exchange national and foreign (males' and females') genotypes through a safe, secure and streamlined process.

During 2022, the Interbull Centre continued to work towards enhancing GenoEx-GDE users' experiences by developing additional web interface features. To improve the quality of the service

¹² [GenoEx.org](https://www.genoex.org)

further, genotype quality control checks in line with the ICAR guidelines - section 4 DNA Technology were also implemented. Furthermore, data exchange and accessibility of the genotypes were enhanced with the implementation of a server and client-side web API, making it possible to streamline the uploading and downloading of genotypes.

GenoEx-GDE was in 2022 extended to more users, as the InterGenomics-Holstein community made preparations for uploading of genotypes through the database for the InterGenomics service in 2023, so that the service is better aligned with the InterGenomics-BSW service.

Table 6.3: Number of genotypes uploaded to GenoEx-GDE

Breed	Genotypes uploaded in 2022		Total number of genotypes	
	Female	Male	Female	Male
Brown Swiss	1 316	4 791	16 404	53 381
Holstein	30 796	13 398	30 796	13 398
Other breeds*	67	38	67	38

* "Other breeds" includes Belgian Blue; Charolais; Hereford; Holstein, Red and White; Jersey; Limousin; Montbeliard and Simmental

6.3. Exchange of Information on Genetic Recessive Traits

The exchange of information on genetic recessive traits takes place through the "AnimInfo" module within the Interbull Data Exchange Area ("IDEA").

Data Exchanged	Service/Database	Purpose	Key Benefits include
Genetic Recessive Traits	IDEA-AnimInfo	Sharing of updated information regarding recessive traits. Identify AI bulls which are carriers of important recessive traits.	Genetic Recessive Trait information on animals tested in other countries becomes available to all participating organisations.

The service is in place for sharing of specific genetic recessive traits in the Holstein breed, Table 6.4. Besides allowing access to a wider set of information and assuring a smoother and more timely exchange of genetic defects' information among participating countries, the service does also allow to effectively reduce the amount of conflicting information among countries. During 2022, Interbull Centre worked together with the InterGenomics-BSW community to test sharing of relevant genetic traits for the BSW breed. During the test, a set of traits and their relative codes have been defined and the procedure of sharing such information via IDEA-AnimInfo, tested thoroughly. The service is expected to be expanded to include BSW in 2023. Interbull Centre also continues to collaborate with the ICAR "Breed Associations" and "Interbeef" Working Groups to expand the service to beef cattle.

Table 6.4: Participation in the exchange of genetic recessive traits.

Organisation	Country	Genetic recessive traits uploaded
Cooperative CRV	The Netherlands	98 883
VIT	Germany	396 138
AHDB	Great Britain	77 573
Total		572 594

7. EUROPEAN UNION REFERENCE CENTRE (EURC)

As the European Union reference centre (EURC Zootechnics - Bovine Breeding), the Interbull Centre is responsible for the scientific and technical contribution to the harmonisation and improvement of the methods of performance testing and genetic evaluation of purebred breeding animals of the bovine species in the European Union.



7.1. Validation

Validation of national EBVs and GEBVs is one of the top priorities to ensure reliable National and International, genetic and genomic evaluations. Conventional Validation tests provide reassurance to the National Genetic Evaluation Centres, cattle organisations and farmers that the bias in their statistical models applied for a given breed/trait are within a tolerated threshold of 2%. This provides an assurance that their statistical models applied are sound and fit their data well, avoiding any under/over estimation of their animals' genetic worth. In 2022 the Interbull Centre provided a total of 443 validation tests to National Genetic Evaluation Centres.

Providing further assistance to European Competence Authorities and in line with the current European Animal Breeding Regulations, Interbull Centre offers the possibility to Breeding Associations and their third parties (including Genetic Evaluation Centres) to assess the correctness of their genetic evaluation models (in matter of level of bias detected) by offering the **EURC Validation service**. This service is offered to Breed Associations and their third parties in European Union Member States, even if a breed or country is not included in international genetic evaluations at the Interbull Centre.

7.2. Performance Recording, Evaluation & Publication Database

For many years, Interbull and Interbeef Service Users and National Genetic Evaluations Centres have been acquainted with Forms "GE", "GENO" and "BEEF" to describe their national systems for performance recording and genetic & genomic evaluation. In March 2022, the Interbull Centre launched the EURC Performance Recording, Evaluation and Publication ("**PREP**") Database; PREP was developed to:

- Enable the Interbull Centre to carry out its activities as EU Reference Centre;
- Facilitate greater transparency of the information performance recording and evaluation;
- Enable the collection of additional information - on additional breeds and traits;
- Harmonise and standardise information that has for many years been recorded in the above-mentioned Forms.

Through the PREP Database, breed societies and third parties designated by breed societies (NGEC's) can give information in a standardised way (rather than 'free text'). It is expected to be most valuable in better comparing and ultimately harmonising performance testing and genetic evaluation methods. The PREP database provides access to harmonised information regarding the trait groups "Production" and "Calving" for dairy cattle, and the traits "Adjusted Weaning Weight", "Birth Weight" and "Calving Ease" for beef cattle. Aided by the standardisation of trait information in the PREP database, the first version of recommended guidelines for recording, editing and evaluating calving traits in dairy cattle was finalised in 2022, resulting in an update of the Interbull Guidelines¹³ ("*Section 09 – Dairy Cattle Genetic Evaluation*"¹⁴).

¹³ <https://www.icar.org/index.php/icar-recording-guidelines/>

¹⁴ <https://www.icar.org/Guidelines/09-Dairy-Cattle-Genetic-Evaluation.pdf>

8. SUPPORT SERVICES to ICAR

In addition to the genetic and genomic evaluations for dairy and beef, the Interbull Centre provides the following technical support to ICAR.

8.1. ICAR Accreditation of DNA Data Interpretation Centres

The Interbull Centre handles the technical component for the ICAR accreditation of DNA Data Interpretation Centres since 2018 by distributing and assessing the necessary test files and results. The test files are created by a programme, 'Cuckoo', that has been developed by Lactanet, Canada.

Since the inception of the service, 58 tests have been assessed by the Interbull Centre.

At the end of 2022, twenty-five organisations were ICAR Accredited DNA Data Interpretation Centres (see ICAR DNA list¹⁵ for the full list). Several of these organisations have been re-accredited, after the original two-year terms of their accreditation came to an end. Visit the ICAR website¹⁶ for further info.

8.2. ICAR Certificate of Quality

The Interbull Centre provides ICAR with information on international genetic and genomic evaluations for the ICAR Certificate of Quality. During 2022, information was provided for 4 Interbull Service Users:

- Arbeitsgemeinschaft Schweizerischer Rinderzuchter (ARS) - Switzerland
- Czech Moravian Breeders Company (CMBC) - Czech Republic
- Agricultural Data Centre (LDC) - Latvia
- SA Studbook (SASB) - South Africa.



¹⁵ <http://tiny.cc/ICARDNAlist>

¹⁶ http://tiny.cc/ICARDNA_ACCR

9. RESEARCH & DEVELOPMENT – Dairy

The following is a summary of research and development activities conducted at the Interbull Centre or with the involvement of Interbull Centre staff in 2022.

9.1. SNP_{Mace}; International SNP Evaluations

The SNP_{Mace} Feasibility Study, completed in 2021, showed the technical feasibility of the SNP_{Mace} Methodology: **more accurate SNP solutions**, and hence **more accurate GEBVs**, can be achieved – **without the exchange of genotypes** – by:

- first analysing training population within a country, and
- then combining the SNP solutions from a range of countries.

SNP_{Mace} Consultation

Considering the significant differences between the current Interbull services and the envisaged SNP_{Mace} service, Interbull organised a SNP_{Mace} Consultation Webinar in November 2021. In early 2022, a SNP_{Mace} consultation Survey was completed, with 32 out of the 34 NGENs completing the survey in early 2022. From the results of the survey, it was concluded that:

- a) There is a good understanding amongst the Interbull Community of the outlined principles and concepts of the SNP_{Mace} Business Model.
- b) Interbull Service Users agree in principle with the presented Business Model and Service Options.
- c) Interest in a SNP_{Mace} Service is relevant across several breed x trait combinations.

Next steps

Based on the study and survey, the Interbull Steering Committee decided to:

1. Continue with developing SNP_{Mace} as a potential new Service to be offered to both “Closed Groups” and “Open Groups”.
2. Start the Implementation phase through Pilot Runs in collaboration with two defined groups: “EuroGenomics” (for Holstein) and “InterGenomics” (for Brown Swiss).

Due to resource constraints at the Interbull Centre, it has not been possible to perform a SNP_{Mace} Pilot Run during 2022. Such Pilot is however envisaged in 2023 prior to offering the Interbull community a potential new service based on the SNP_{Mace} method.

In preparation for performing a Pilot Run, the following was established during 2022:

- Both EuroGenomics and InterGenomics-Brown Swiss showed interest in the Interbull SNP_{Mace} project.
- EuroGenomics would not participate in a Pilot Run due to resource constraints, and their focus on the equivalent EuroGenomics project.
- InterGenomics-Brown Swiss also had its limitations in resources. However, the InterGenomics-Brown Swiss committed to a SNP_{Mace} Pilot Run (despite limitations in resources) as Brown Swiss data from all InterGenomics countries may be used for the Pilot Run. The Pilot Run would involve active participation by sub-set of countries; and production of input data for the other countries by Interbull Centre.

9.2. Genomic Reliabilities (“GREL”) WG

The Genomic Reliability Working Group continued investigating the Interbull GREL method for single step models. In 2022, investigations were particularly focused on improving computational time by using a reduced subset of SNPs. The basic scenario was considered the time required when processing a German single-step dataset with 1 million genotyped animals, including 350 000 reference animals. Reliability calculations for such full dataset took 3 hours on 10 cores. Several reduced datasets were tested, containing SNPs selected at the following intervals: every 2nd, 3rd, 4th, 5th and 10th marker. The investigation pointed out that at least 15 000 SNPs were needed for an accurate prediction of reliabilities.

The working group has also successfully tested “snp_blup_rel” software for new animals only (up to 20 000 genotypes), simulating weekly evaluations for candidate animals.

The above investigations have led to a new, faster version of “snp_blup_rel” becoming available.

9.3. Genomic Pre-selection (“GPS”) and Future MACE WG

The Future MACE working group has defined and tested the effects of different models to best fit genomic preselection in the MACE model. When dealing with GPS effects, the working group realised that two main scenarios needed to be taken in consideration to properly account for such effects for all types of bulls:

- Bulls pre-selected and proven in country of birth and then also proven in another country.
- Bulls sold, pre-selected and proven in country 2, without being selected or proven in country of birth.

The model derived from these considerations resulted in the following approach:

- pre-selection countries were limited, in order to have a minimum population’s size:
- pre-selection effects were assumed to be zero or very negligible for countries with a very small population size.

Application of this approach would still result in the majority of participating countries to be included in the analysis. The new model allowed an estimation of the genomic pre-selection effect that appeared to be more internationally based compared to the other models tested. The incidence of pre-selection effect on imported bulls would then get multiplied by the regression from the selecting to the proven country’s scale.

The new model identified looks promising and the working group continues fine-tuning it for a possible implementation at the earliest opportunity.

9.4. Genomic-free EBV Recommendations

The Genomic-free EBV WG has been dormant following its recommendations during the Interbull webinar of 11 February 2021. The WG’s recommendations, are still considered relevant and actual and should be applied by countries having implemented a Single Step evaluation and wanting to provide their EBVs to the MACE evaluation (in anticipation of the results of the GPS and Future MACE WG). The WG’s main recommendations¹⁷, and a recording¹⁸ of the webinar are available on the Interbull website.

¹⁷ https://interbull.org/ib/2021_webinar_summary

¹⁸ https://interbull.org/static/presentations/Interbull_webinar_Genomic-free_EBV.mp4

9.5. Validation WG

The Validation Working Group continues its investigations in defining new regression tests that can 1) better detect any bias due to genomic pre-selection and 2) preserve their statistical power even in situations where the number of proven bulls is reducing. The working group developed in 2022 an enhanced version of the GEBV test which will allow users to perform the following additional steps:

- Analyse and adjust the base of expression in Reduced data to match Full data
- Allow different validation targets: Allowing validation targets like GEBV that are not biased by GPS (e.g. Legarra-Reverter)
- Apply unweighted regression and correlation tests, instead of the standard weighted regressions used for Interbull validation tests.

The new software has been tested by members of the working group and the Interbull Technical Committee. The WG continues to fine-tune the software on the basis of feedback received.

10. RESEARCH & DEVELOPMENT – Beef

10.1. Interbeef Carcass traits evaluation

As a follow up to the research on international evaluations for carcass traits in 2021, a new data call was issued in 2022, and the following data was received:

- **Traits:** Carcass weight (cwe), Carcass conformation (cco) and Carcass fat (cfa).
- **Breeds:** Charolais, Limousin and Simmental.
- **Countries:** DFS (Denmark, Finland and Sweden), Ireland, Switzerland and the United Kingdom.



In October/November 2022, a pilot run was performed, and results were considered to be satisfactory by all participating countries. With sufficient interest in participation, and approval by the Interbeef WG, the first official test evaluation for carcass traits is envisioned for April 2023.

10.2. Interbeef Female Fertility traits WG

After the data call for the number of calving (nca) and calving interval (cai) in 2021, Wolfgang Ruten and Nicolas Frioni (vit, DEU) began the development of a pipeline for the evaluation of fertility traits. During 2022 the pipeline to obtain the estimated breeding values of the animals for nca and cai was completed. However, there is still an issue to fix on the estimation of reliability. The WG continues to research this topic as well as the evaluation model improvement.

10.3. Validation of national and international beef models WG

Model validation in beef evaluations has its own particularities. These particularities do not allow the methods (Interbull Method I, II, III and IV) already established for dairy evaluations to be directly implemented in beef evaluations. However, this does not mean that they cannot be used.

Research for validation in beef evaluations has focused on two methods: “Mendelian Sampling Variance Test” and Trend Validation Test, Method II; analysis of within yearly bull DYD.

1. Mendelian Sampling Variance Test: The Working Group has identified a criterion for selecting bulls to participate in the test based on Effective Record Contribution. Tests have been carried out on data from Ireland and Italy with promising results, but further validation of the method in beef is still needed.
2. Trend Validation Test, Method II: Nowadays, the use of genomic information at national level has increased and “Method II” is more appropriated for genomic evaluations. A first application of the method with international data has been carried out. The Working Group plans to expand the testing to national data from Ireland and Italy in future research.

10.4. Interbeef Genomic Task Force

In the last decade, many countries with beef cattle evaluations have adopted, or are in the process of developing, national genomic evaluations. Interbeef WG is no stranger to this situation and has supported research to develop international beef genomic evaluations (see §12.2). The Interbeef Genomic Task Force was formed during 2022 to evaluate and establish the basis for a future international genomic evaluation. The Interbull Centre team has been actively working with the Task Force, providing information and outlining development plans. The work of the Task Force continues in 2023 before development plans can be implemented.

10.5. Interbeef Information exchange WG

The Interbeef Information exchange WG was established by the Interbeef WG in July 2021 to address open questions related to Interbeef information exchange, with particular focus on Genetic information, Cross-bred animal identification, and Pedigree data. Since its inception, the WG has had several meetings, identifying the following additional information as of interest for further sharing between the members:

1. Deeper Pedigree information
2. Genotype information
3. Phenotype information

For each of such information the WG defined and proposed processes for sharing of the information including reference to business rules. The final report from the working group has been presented to the Interbeef Working Group meeting in November 2022. The different actions and processes therein described, although found relevant, have been given a lower priority compared to other more urgent research topics, they will be therefore scheduled for implementation in the next couple of years.

With the delivery of the final report, the activity of the Interbeef Information Exchange working group is considered finished, the working group has been temporally disbanded until implementation of the different process will begin.

10.6. ICAR/Interbeef/BIF Guidelines

The ICAR/Interbeef/BIF Guidelines WG activity is focused on reviewing and updating ICAR guidelines, taking this as an opportunity to align them with the BIF ones to reach harmonisation at the international level. Within the WG, an agreement between ICAR/Interbeef and BIF has been reached to undertake a pilot project, to develop joint wiki-based beef recording guidelines.

11. INTERBULL CENTRE INFRASTRUCTURE & DATA EXCHANGE

The Interbull Centre has an efficient, effective, versatile, scalable, and powerful computing infrastructure. It consists of customer facing software services and databases for the exchange of data and information: *Interbull Data Exchange Area* (“IDEA”), *International Genotype Exchange Platform* (“GenoEx”) and *Performance Recording, Evaluation and Publication Database* (“PREP”), as well as a cluster system with attached clustered file storage that is used for high-performance data analysis and tools for system monitoring, operational system management, backups, communication, and project management.

Software costs are kept manageable by using many well-vetted Open Source components, while the performance and ease of maintenance of the system has been honed by years of experience doing large-scale data analysis at the Interbull Centre.

The Interbull Centre continues to invest in infrastructure improvement in order to continue to provide an increasing number of services efficiently.

11.1. System Maintenance, Development and Security

During 2022, system administration focused particularly on the following areas:

- Update of systems and operating systems.
- Implementation of redundancy for specific servers, to maximise uptime and minimise downtime at disaster recovery.
- Migration of IDEA server from CentOS to Debian.
- Configuration and launch of PREP Database¹⁹.
- Update of gfortran programs to meet the requirements of modern gfortran compiler. Interbull Centre staff, with the help of external experts, commenced upgrading all Fortran programs used in the provision of international evaluation services to the 2018 standard version of Fortran. This work will be continued in 2023.

¹⁹ [PREP.interbull.org](https://prep.interbull.org)

12. RESEARCH & DEVELOPMENT – External funding

In addition to funds raised from service fees, research and development activities at the Interbull Centre are financed by grants from the Swedish University of Agricultural Sciences (SLU) and the European Union. Contributions of the above organisations to the development of Interbull Centre services are gratefully acknowledged.

At the start of 2022, was involved with two internationally funded projects; “GenTORE” and “International Genetic and Genomic Evaluations of Beef Cattle”. Both projects were completed in 2022. The Interbull Centre did not join other such projects in 2022.

In line with the Interbull 2020-2023 Strategic Plan, Interbull Centre’s involvement in international consortia focuses on:

- providing services to the project (enabling international exchange of data; quality control), and
- developing services to the Interbull and Interbeef Communities.

12.1. GenTORE

The Horizon2020 funded project “Genomic management tools to optimise resilience and efficiency” (GenTORE^{20 21}) was carried out between 1 June 2017 and 31 May 2022.

One of GenTORE’s aims is to develop new evaluations for traits related to efficiency and resilience. The majority of Interbull Centre’s activities in the project was completed in 2021; Interbull Centre collected and stored performance data from Interbeef members (Denmark, Finland, Ireland, Sweden, and Switzerland) on “Age at slaughter” for Limousin and Simmental beef cattle in the IDEA Performance Database, and estimated international breeding values and their reliabilities in each country scale. The results were presented to Interbeef during the Interbeef WG and Technical Committee meeting on 12 July 2022.

Since among the countries participating to the international evaluation of ‘Age at Slaughter’ only Ireland (ICBF) has a national genetic evaluation in place for this trait, this evaluation can provide farmers in participating countries with an additional tool to select breeding animals on efficiency – and the Irish farmers with an improved tool.



12.2. International Genetic and Genomic Evaluations of Beef Cattle

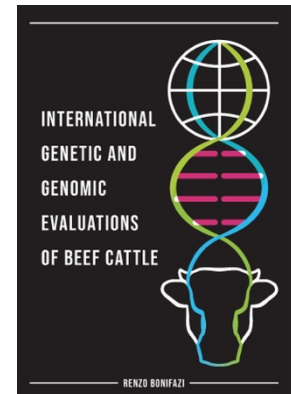
On 16 September 2022, Dr Renzo Bonifazi successfully defended his PhD project, “International genetic and genomic evaluations of beef cattle”. The results from Renzo’s PhD led to the creation of the Interbeef Genomic Task Force to address steps towards a new Interbeef service based on genomic information (see §10.4).

²⁰ www.GenTORE.eu

²¹ www.interbull.org/ib/gentore

The aim of Renzo's PhD project was to improve and further develop methodologies for international beef cattle evaluations. The results in this thesis support that international beef genetic evaluations are beneficial for both large and small participating countries, and that these evaluations should be extended to incorporate genomic information.

International evaluations require genetic correlations between countries that are typically difficult to estimate. Renzo developed data sub-setting strategies that improved computational time while yielding proper estimates. He also showed that the current practice of assuming across-country direct-maternal genetic correlations to be 0 has limited impact on the obtained breeding values, while assuming zero within-country direct-maternal genetic correlations does affect the breeding values obtained. Following the uptake of using genomic information in beef cattle breeding, Renzo developed international genomic evaluations for beef cattle using a single-step model that yielded higher accuracies compared to both current international pedigree evaluations and either national pedigree or genomic evaluations. Finally, a generalized procedure to integrate pedigree-based or single-step international breeding values in national evaluations was developed, and its added benefit was demonstrated.



The research described in Renzo's thesis was financially supported by the ICAR, Interbeef, Interbull and the Irish Cattle Breeding Federation (ICBF).

Renzo's thesis is available as eBook²² and as pdf²³.

²² https://www.globalacademicpress.com/ebooks/renzo_bonifazi/

²³ <https://doi.org/10.18174/572085>

13. MEETINGS, COMMUNICATIONS and PUBLICATIONS

13.1. 2022 Interbull Annual Meeting

Due to the Covid-19 pandemic, the 2020 Annual Meeting was cancelled, and the 2021 Annual Meeting was organised as a virtual meeting. The 2022 ICAR-Interbull Meeting, held in Montréal, Québec, Canada, from 30 May until 3 June



2022, was the first face-to-face annual meeting since 2019. A total of 129 registered to attend the Interbull meeting (with an additional 63 following online livestreams of the meetings). It was very nice, interesting, and useful to see so many participants during the Interbull Open Meetings and Business Meeting on 30 and 31 May 2022.

During the Business Meeting the Interbull activities were presented by the Interbull Chair, members of Interbull Committees and Interbull Centre staff, covering Interbull Governance, Interbull Centre's finances, services, R&D and operations (Dairy, Beef and SNP services).

The Open Meetings addressed *"New traits in genetic and genomic evaluation systems"*, *"Experiences at national level with single-step evaluations"*, *"New methods, validation, harmonisation, dairy cross-breeding and beef evaluations"*.

The ICAR-Interbull joint session *"Recording and selection tools for feed efficiency and environmental impact"* provided the participants with the latest updates on these relevant topics.

On the Interbull website you will find the public materials for the Business Meeting²⁴, and presentations of the Open Meetings²⁵ and ICAR-Interbull joint session²⁶, while the papers of these presentations have been published in Interbull Bulletin No. 57²⁷.

13.2. Future Interbull Annual Meetings

Upcoming Interbull Annual Meetings have been scheduled as follows:

2023: Interbull Annual Meeting in conjunction with the 74th EAAP meeting in Lyon, France.



2024: Joint ICAR-Interbull Meeting. Venue and dates to be confirmed.

13.3. Interbull Bulletin and Websites

The **Interbull Bulletin** contains the state-of-the-art in genetic evaluation methods, as well as the most recent information on national and international implementations. The Proceedings of the 2022 Interbull Meeting were published in Interbull Bulletin No. 57 in September 2022. This issue as well as back issues can be accessed through the online *Interbull Bulletin*²⁷.

The **Interbull**²⁸ and **GenoEx**²⁹ websites have been updated with the latest information, including the 2022 Interbull Centre Activity and Finance Reports, and Strategic and Annual Operating Plans³⁰.

²⁴ https://interbull.org/ib/2022_bm_montreal

²⁵ https://interbull.org/ib/2022_scientific_programme (only presentations for which permission to publish has been received)

²⁶ https://interbull.org/ib/2022_icar_interbull_joint_session

²⁷ <https://journal.interbull.org/>

²⁸ <https://interbull.org>

²⁹ <https://GenoEx.org>

³⁰ <http://interbull.org/ib/itbcreports>

The latest information on **Interbeef** is shared with ICAR so relevant Interbeef pages on the ICAR website³¹ can be updated.

Pictures of Interbull events remain available in the “**Hall of Fame**”³².

13.4. Publications by Interbull Centre staff

Nyman S., Johansson A. M., **Palucci V.**, Schönherz A. A., Guldbrandtsen B., Hinrichs D, de Koning D.J., 2022: Inbreeding and pedigree analysis of the European red dairy cattle, Genetic Selection Evolution 2022 54:70. <https://gsejournal.biomedcentral.com/articles/10.1186/s12711-022-00761-3>

Zaabza, H.B., Van Tassell C.P., Vandenplas J., VanRaden P., Liu Z., Eding H., McKay S., **Haugaard K.**, Lidauer M.H., Mäntysaari E.A. Strandén I., 2022. Invited review: Reliability computation from the animal model era to the single-step genomic model era. J. Dairy Sci. 106:1518-1532. <https://doi.org/10.3168/jds.2022-22629>

³¹ <https://www.icar.org/index.php/technical-bodies/working-groups/interbeef-working-group/>

³² <http://interbull30years.blogspot.se/>

Appendix 1: Interbull and Interbeef Committee, Working Group and Task Force compositions.

Interbull Centre personnel are represented in various Committees, Task Forces and Working Groups. Full membership for these groups as on 31 December 2022 is provided below³³.

Within brackets are members of the Interbull Centre team who regularly attend the meetings of the group, even if not official group members.

ICAR's Sub-Committees and Working Groups:

- **Interbull Steering Committee:**
Matthew Shaffer (Chair), Brian Van Doormaal (Vice-Chair), Gerben de Jong, Marija Klopčič, Sophie Mattalia, Gert Pedersen Aamand, Daniele Vicario, Ezequiel Nicolazzi, Urs Schnyder (**Toine Roozen, Valentina Palucci**).
- **ICAR ID Subcommittee:**
Jo Quigley (Chair), Kaivo Ilves, Folkert Vonken, **Valentina Palucci**, Othon Reynoso Campos.
- **ICAR DNA WG:**
Romy Morrin-O'Donnell (Chair), Brian Van Doormaal, André Eggen, Suzanne Harding, Dariusz Kamola, Matthew McClure, Nilesh Nayee, Ezequiel Nicolazzi, **Joanna Sendeck**, Jiansheng Qiu, Clotilde Patry, Johan De Meulemeester.
- **Interbeef WG:**
Andrew Cromie (Chair), Steve Miller, Gert Pedersen Aamand, Mike Coffey, Mauro Fioretti, Laurent Griffon, Thomas Schmidt, Svenja Strasser, Mart Uba, Mojca Voljc, Japie van der Westhuizen (**Fernando Macedo, Toine Roozen, Katrine Haugaard, Valentina Palucci**).
- **Beef Genetic Traits WG:**
Suzanne Harding (chair), Jennifer McClure, Matthew McClure, Catalin Rotar, Steven Skinner, Alena Svitakova, Kevin Byskov, Pauline Michot (**Valentina Palucci**).

Interbull Steering Committee's Working Groups and Task Forces:

- **Interbull Technical Committee:**
Gerben de Jong (Chair), Tom Lawlor, Paul VanRaden, Zengting Liu, Raphael Mrode, Esa Mäntysaari, Peter Sullivan, **Valentina Palucci (Katrine Haugaard, Fernando Macedo)**.
- **EU Reference Centre WG:**
Sophie Mattalia (Chair), Marija Klopčič, **Toine Roozen, Joanna Sendeck, Valentina Palucci**.
- **Business Funding Models Task Force:**
Brian Van Doormaal (Chair), Laurent Journaux, Urs Schnyder, Gert Pedersen Aamand, Gerben de Jong, **Toine Roozen**.
- **InterGenomic-Holstein WG:**
Marija Klopčič (Chair), Sophie Mattalia, Brian Van Doormaal, **Toine Roozen, Katrine Haugaard**.
- **New Traits Pipeline WG:**
Gerben de Jong, Ezequiel Nicolazzi, **Toine Roozen, Valentina Palucci**.

³³ While R&D Manager at the Interbull Centre, Simone Savoia was a member of the following Committees and Working Groups:
Interbull: Interbull Technical Committee, InterGenomics-Holstein WG, Genomic Pre-selection (GPS) & Future MACE WG, SNP MACE WG
Interbeef: Interbeef WG, Interbeef Female Fertility WG, Technical Working Group, VCE WG

Interbull Technical Committee's Working Groups:

- **Genomic Reliability (GREL) WG:**
Zengting Liu (Chair), Mario Calus, Martin Lidauer, Vincent Ducrocq, Paul VanRaden, **Katrine Haugaard**.
- **Genomic Pre-selection (GPS) & Future MACE WG:**
Pete Sullivan (Chair), Esa Mäntysaari, Gerben de Jong, **Simone Savoia, Valentina Palucci**.
- **Validation WG:**
Esa Mäntysaari (Chair), Zengting Liu, Paul VanRaden, Pete Sullivan, Raphael Mrode, **Valentina Palucci**.
- **SNPMace WG³⁴:**
Mike Goddard, Vincent Ducrocq, Esa Mäntysaari, Zengting Liu.

Interbeef Working Groups:

- **Interbeef Technical Working Group:**
Romain Saintilan (Chair), Andrew Cromie, Thierry Pabiou, Ross Evans, Alena Svitakova, Wolfgang Ruten, Elisenda Rius-Vilarrasa, Laurent Griffon, Brad Crook, Sophie Kunz, Mart Una, Barbara Lustreck, Stéphane Barbier, Stefano Biffani, Martino Cassandro, Riccardo Bozzi, **Fernando Macedo (Katrine Haugaard, Valentina Palucci, Toine Roozen)**.
- **Interbeef Validation WG:**
Ross Evans (Chair), Thierry Pabiou, Romain Saintilan, Stefano Biffani, Dorian Garrick, Roel Veerkamp, Esa Mäntysaari, **Fernando Macedo**.
- **Interbeef VCE WG³⁵:**
Thierry Pabiou (Chair), Wolfgang Ruten, Zdenka Vesela, Sophie Kunz, **Fernando Macedo**.
- **Interbeef Female Fertility WG:**
Wolfgang Ruten (Chair), Nicolas Frioni, Dierck Segelke, Romain Saintilan, Thierry Pabiou, Sophie Kunz, Stefano Biffani.
- **Interbeef Information Exchange WG:**
Laurent Griffon (Chair), Sophie Kunz, Thomas Schmidt, Thierry Pabiou, **Valentina Palucci**.
- **ICAR/Interbeef/BIF Guidelines WG:**
Martin Burke (Chair), Andrew Cromie, Japie van der Westhuizen, Darrh Bullock, Bruce Golden, **Valentina Palucci**.
- **Interbeef Genomic Task Force>**
Andrew Cromie (Chair), Ross Evans, Thomas Schmidt, Franz Seefried, Julien Mante, Mojca Voljč, Laurent Griffon, Mart Uba, Gert Pedersen Aamand, Sophie Kunz, Kristīne Ādama, Alena Svitáková, Kim Matthews, Stefano Biffani, Simone Callegro, **Toine Roozen (Katrine Haugaard, Fernando Macedo)**.

³⁴ The SNPMace WG has been transferred from SC to ITC to address technical questions, which will be addressed (once new resources have been allocated to a SNPMace Pilot Run/2023). The WG has been dormant in 2022.

³⁵ The development of genomic evaluations may affect the way in which variance components are currently estimated. As a result, the Interbeef VCE WG was dormant in 2022, but is expected to be reactivated once beef genomic evaluation activities have been clarified.

Appendix 2: Interbull Centre Staff: Training, Courses, Meetings and Conferences

Interbull Centre staff is involved with many courses, meetings and conferences. Due to the persisting emergency related to the Covid-19 Pandemic the majority of the events that were scheduled during this reporting period were attended via video conference. Attendance details are given in Tables App2.1-4.

App2.1: Provision of training during 2022

Courses provided	Dates	Person
Course on International evaluation and Interbull activities (Lecture in Animalieproduktion - idisslare)	7 November 2022	Valentina Palucci
Course on nordic beef breeding (Lecture in Animalieproduktion - idisslare)	2 December 2022	Katrine Haugaard
Interbull Webinar on PREP database and New Traits Pipeline	31 March 2022	Valentina Palucci, Toine Roozen, Joanna Sendeck, Simone Savoia, Fernando Macedo, Katrine Haugaard
Interbull Webinar on "Integration of International (G)EBV in national evaluations"	11 April 2022	Simone Savoia

Highschool student **Gustav Hammarberg** spent 8 weeks at the Interbull Centre under the supervision of Marcus Pedersen as part of a "school-work" program.

App2.2: Attendance of events during 2022

Event	Dates	Attendee
Libre Planet 2022 (Online)	19-20 March 2022	Marcus Pedersen
BIF & ICAR	28 March 2022	Valentina Palucci
Interbull Centre Internal Audit	18 August 2022 25 August 2022	Toine Roozen, Marcus Pedersen, Valentina Palucci
Interbull Technical Strategic Meeting (Montreal)	26-27 May 2022	Joanna Sendeck (Online), Fernando Macedo, (Online), Katrine Haugaard, Simone Savoia, Valentina Palucci, Toine Roozen
2022 ICAR-Interbull conference	30 May-3 June 2022	Joanna Sendeck (Online), Fernando Macedo, (Online), Katrine Haugaard, Simone Savoia, Valentina Palucci, Toine Roozen
WCGALP 2022 (Rotterdam)	3-8 July 2022	Simone Savoia
ISO 9001 External Audit	8 November 2022	Valentina Palucci, Toine Roozen, Joanna Sendeck, Katrine Haugaard, Fernando Macedo

App2.3: Interbull Committee Meetings; 2022

Event	Dates	Attendee
Steering Committee	16 February 2022 28 April 2022 29 May 2022 31 May 2022 12 September 2022 17 November 2022 15 December 2022	Toine Roozen, Valentina Palucci
Technical Committee	8 March 2022	Fernando Macedo, Katrine Haugaard, Simone Savoia, Valentina Palucci
	27 May 2022 (Montreal)	Joanna Sendeck (Online), Fernando Macedo, (Online), Katrine Haugaard, Simone Savoia, Valentina Palucci
	28 May 2022 (Montreal)	Joanna Sendeck (Online), Fernando Macedo, (Online), Katrine Haugaard, Simone Savoia, Valentina Palucci
	31 May 2022 (Montreal)	Joanna Sendeck (Online), Fernando Macedo, (Online), Katrine Haugaard, Simone Savoia, Valentina Palucci
	3 November 2022	Joanna Sendeck, Fernando Macedo, Katrine Haugaard, Valentina Palucci
Business Funding Models Task Force (BFMTF)	24 January 2022 09 February 2022 14 February 2022 14 November 2022	Toine Roozen, Simone Savoia, Valentina Palucci
New Traits Pipeline (NTP) WG	28 January 2022 18 February 2022 28 February 2022 18 March 2022 12 August 2022 14 October 2022 16 December 2022	Valentina Palucci, Toine Roozen
2022 Interbull Annual Meeting (joint ICAR -Interbull 2022 LOC)	21 January 2022 03 February 2022 17 February 2022 22 March 2022 13 April 2022 6 May 2022 12 May 2022 24 May 2022 29 July 2022	Valentina Palucci and/or Toine Roozen
2023 Interbull Annual Meeting (joint EAAP-Interbull 2023 LOC)	09 March 2022	Valentina Palucci
ITC Chair – Interbull	5 September 2022 7 November 2022 5 December 2022	Valentina Palucci, Toine Roozen
InterGenomics Technical Meeting	07 April 2022	Katrine Haugaard, Simone Savoia, Toine Roozen
	23 August 2022	Valentina Palucci, Katrine Haugaard
InterGenomics-Holstein Technical Meeting	29 June 2022	Simone Savoia, Toine Roozen,
	1 November 2022	Valentina Palucci, Katrine Haugaard
InterGenomics MGMT meeting	18 May 2022	Simone Savoia, Toine Roozen, Katrine Haugaard
	14 November	Valentina Palucci, Katrine Haugaard

App2.4: Working Group and Task Force Meetings by Conference call; 2022

Group	Dates	Attendee
INTERBULL Technical groups		
Validation Working Group	15 February 2022 27 July 2022 6 October 2022 31 October 2022	Valentina Palucci
Future MACE WG	20 October 2022	Valentina Palucci
Interbull Technical Workshop 2023	21 November 2022 14 December 2022	Valentina Palucci, Toine Roozen
ICAR		
ICAR ID-Subcommittee	18 March 2022 30 May 2022 (Montreal)	Valentina Palucci
ICAR-BIF Guidelines Collaboration	28 March 2022	Valentina Palucci
DNA working group	1 February 2022 18 May 2022 6 September 2022 16 November 2022	
Interbeef		
Interbeef Working Group	21 January 2022	Fernando Macedo, Katrine Haugaard, Simone Savoia, Toine Roozen, Valentina Palucci
	11 March 2022	Fernando Macedo, Katrine Haugaard, Simone Savoia, Toine Roozen, Valentina Palucci
	29 May 2022 (Montreal)	Fernando Macedo (Online), Katrine Haugaard, Simone Savoia
	12 July 2022	Fernando Macedo, Katrine Haugaard, Simone Savoia, Toine Roozen, Valentina Palucci
	22 November 2022	Fernando Macedo, Toine Roozen, Valentina Palucci, Katrine Haugaard
Interbeef Technical Committee	21 January 2022 11 March 2022	Fernando Macedo, Katrine Haugaard, Simone Savoia, Toine Roozen, Valentina Palucci
	11 March 2022	Fernando Macedo, Katrine Haugaard, Simone Savoia, Toine Roozen, Valentina Palucci
	29 May 2022 (Montreal)	Fernando Macedo (Online), Katrine Haugaard, Simone Savoia
	12 July 2022	Fernando Macedo, Katrine Haugaard, Simone Savoia, Toine Roozen, Valentina Palucci
	22 November 2022	Fernando Macedo, Katrine Haugaard, Toine Roozen, Valentina Palucci
ITBC- Interbeef Chairs meeting	12 January 2022 02 February 2022 02 March 2022 06 April 2022 04 May 2022 01 July 2022 12 October 2022 2 November 2022 1 December 2022	Toine Roozen, Simone Savoia, Fernando Macedo, Valentina Palucci
Validation working group	19 January 2022 28 February 2022 06 May 2022 17 June 2022 13 September 2022 19 October 2022 21 October 2022	Fernando Macedo, Simone Savoia

Female Fertility working group	02 March 2022 06 October 2022 17 November 2022	Simone Savoia, Fernando Macedo
Carcass Evaluation working group	14 January 2022 18 February 2022 07 October 2022 17 October 2022	Simone Savoia, Fernando Macedo
Interbeef Genomic Task Force	9 February 2022 9 March 2022 28 March 2022 21 April 2022 12 May 2022 10 June 2022 22 August 2022 29 September 2022 24 October 2022 12 December 2022	Simone Savoia, Valentina Palucci, Toine Roozen, Fernando Macedo
Data Exchange Working Group	09 March 2022 27 April 2022 13 July 2022 19 October 2022 27 October 2022	Valentina Palucci
Semestral supervisory meeting Renzo Bonifazi's PhD	3 March 2022	Simone Savoia
EU Reference Centre		
EURC WG	14 March 2022 26 August 2022 9 September 2022	Joanna Senddecka, Valentina Palucci, Toine Roozen
Meeting with EURC for Endangered Animal Breeds	27 September 2022	Toine Roozen
Meeting with CA	30 September 2022 18 October 2022 9 November 2022	Joanna Senddecka, Valentina Palucci
Meeting with EC Standing Committee on Zootechnics	3 October 2022	Toine Roozen
Annual EURL and EURC Directors meeting	28 October 2022	Toine Roozen