

Interbull Centre Activity Report



January - December 2021

INTERBULL CENTRE

ACTIVITY REPORT 2021

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

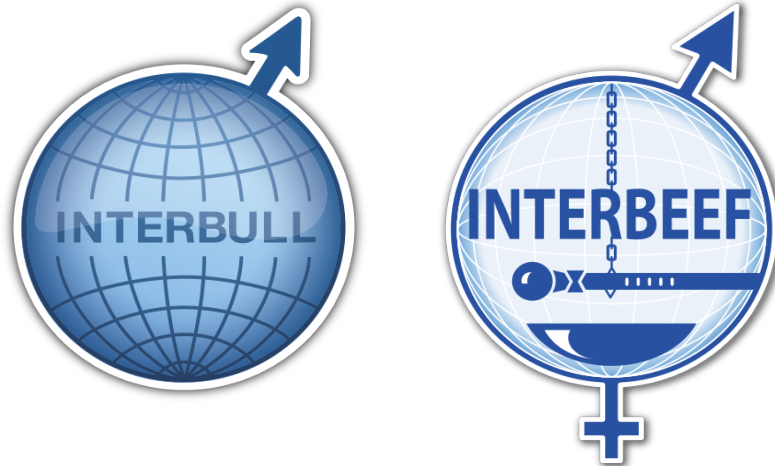




INTERBULL CENTRE ACTIVITY REPORT 2021

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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 2021.

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FOREWORD – Interbull Centre Director

Recent Interbull Centre Activity Reports covered the period between two Interbull Annual Meetings. As a result, the period covered by the report could vary from very few months (leading up to the Annual Meeting in February 2018) to more than one year. The current Activity Report covers the whole of 2021. And it is the intention for future Activity Reports to also cover calendar years. This brings the activity and finance reporting in sync, both covering the same calendar year.

The key goals that were identified in the Interbull 2020-2023 Strategic plan have been leading in the development of our first Annual Operating Plan, which in turn has been guiding in the delivery of the Services and R&D described in the 2021 Activity Report.

Due to the ongoing Covid-19 Pandemic, the Interbull Annual Meeting, was organised, in conjunction with ICAR, as a virtual meeting. Based on the feedback received, it was a successful event. Despite Covid-19 Pandemic all our services have been delivered on time and 'as usual'.

I'd like to express my sincere thanks to all Committees, Working Groups, Task Forces, organisations and individuals who continue to contribute to the Interbull, Interbeef, GenoEx and EU Reference Centre successes, but especially to the Interbull Centre Team.

Kind Regards,

Toine Roozen,
Interbull Centre Director



FOREWORD – Interbull Steering Committee Chair

2021 was another challenging year for our whole international community. While we did manage to organise the annual meeting, complete with business meetings and open sessions, we still missed the networking opportunities and our shared learning that normally play such an important role in our industry. We appreciated the work put in by the organisers in Leeuwarden for all their efforts to make the event happen.

In 2021 Interbull also built on the activities that were started in 2020:

- Using the Strategic plan as the guide, we completed our first Annual Operating Plan.
- We introduced a new service at the start of 2021: “SNP Training for clinical mastitis” (“cma”).
- The Interbull SC commissioned a Interbull Governance Review, the outcomes of which we will look forward to sharing with the Interbull Community in Montreal.
- The SNPMace project moved from its feasibility phase into a more focused consultation on the implementation phase. Interbull Service Users were invited to participate in the consultation as to next steps for SNPMace with a number of webinars and a survey to help inform any future service.

Both the Interbull Steering Committee and the Interbull Technical Committee welcomed new members and it has been great to see their contribution. I would like to thank them, and all Interbull Committees and Working Groups that are such an important component in the international genetic evaluation space. Without the time given up by these contributors, the work of Interbull would not be possible.

I would also like to extend a special thanks to my fellow members of the Interbull Steering Committee. They have continued to meet regularly throughout this period and have given freely of their time to guide the future of Interbull.

Thank you to the Interbull Centre staff led by Toine for their continued efforts on behalf of our community.

I look forward to a return to face-to-face meetings in Montreal and catching up with our friends and colleagues for the first time in over two years!

Warm Regards,

Matthew Shaffer,
Chair, Interbull Steering Committee

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). The team currently consists of the following members of staff:

- Toine Roozen (MSc, MBA) – Director
- Valentina Palucci (MSc) – Service and Quality Manager
- Simone Savoia (PhD) – R&D Manager

Genetic Data Analyst (*Genetics*):

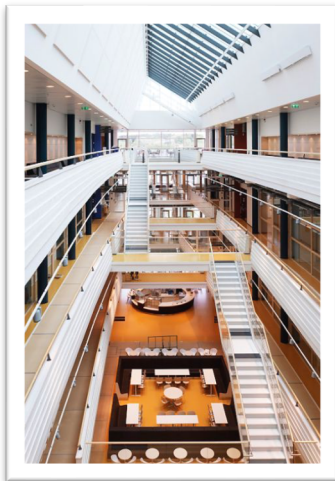
- Joanna Sendicka (PhD)
- Fernando Macedo (PhD)
- Katrine Hugaard (PhD)

Genetic Data Analyst (*Information Technology*):

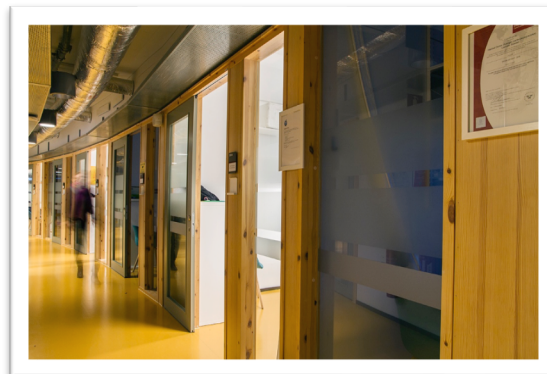
- Marcus Pedersén - Systems Administrator, IT Coordinator
- Carl Wasserman - Systems Developer
- Hans Persson - Programmer
- Jan-Erik Strömqvist - Programmer

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

- Cano Merkan - IT Coordinator / Systems Analyst
- Sofie Lennartsson (BA) – HR, Administrator



The Interbull Centre offices have been empty for most of 2021 due to the Covid-19 Pandemic. The Team is looking forward to meeting many of you at the 2022 ICAR-Interbull meeting in Montreal.



Staff changes

After working nearly 2 years at the Interbull Centre, in February 2021 **Alexis Michenet** accepted another job opportunity, taking him back to France. In his short time at the Interbull Centre Alexis has contributed a lot on the improvement of beef services and has been a great addition to the team. We warmly thank him for his time.

Two geneticists joined the Interbull Centre in 2021:

Fernando Macedo completed his Ph.D. in March 2021 and started at the Interbull Centre on 26 April 2021. Linked to the family farm since childhood, Fernando decided to pursue a career in Veterinary Medicine. At the University, he began his academic activity as a teacher of Animal Breeding. After the Veterinary degree, Fernando earned his M.Sc. at INIA (Uruguay), developing a SNP panel to check paternity in Uruguayan Merino and Corriedale sheep. At INIA, he also worked in studies of residual feed intake and carcass and meat quality in Hereford beef cattle. Fernando's Ph.D. study at INRAE (France) addressed the analysis of bias in genetic and genomic evaluations of dairy sheep.

Fernando's main responsibility at Interbull Centre consists of providing support to all the dairy and beef operational services. Fernando is involved in EU Reference Centre activities and Interbeef R&D projects.

Katrine Haugaard joined the Interbull Centre as a Genetic Data Analyst on 1 July 2021. Katrine earned her Ph.D. at the Norwegian University of Life Sciences on the topic of "Genetic analysis of pathogen-specific mastitis". Most recently, she has been working as a researcher in the Norwegian beef breeding association, "TYR", where her main tasks were routine genetic evaluations and implementation of new traits. Katrine's main responsibility at Interbull Centre is to provide support to all dairy and beef operational services. Moreover, Katrine is involved in dairy R&D projects.

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. 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 Appendix 2.

1.4. Consultants, Suppliers and Visitors

Due to the persisting emergency of the Covid-19 pandemic, Interbull Centre had very few visitors during the current reporting period. Beneficial collaborations are however still in place.

- **Pete Sullivan** (Lactanet, Canada): works as a part time consultant (25%). During 2021, Pete's activities were related to supporting GMACE software (§9.1); main contributions to the Working Groups on "Genomic-Free EBV" (§9.5, including delivery of the related seminar), "Genomic Pre-selection and Future MACE" (§9.4), and software improvements for Interbeef reliabilities.
- **Thierry Pabiou** (ICBF, Ireland): supplies international genetic parameters for Adjusted Weaning Weight (AWW) and Carcass traits (CARC) for Interbeef evaluations (§5) and for "Age at Slaughter" for "GenTORE" project (§10.1) to the Interbull Centre.

- **Zdenka Vezela** (CMBC, Czech Republic): supplies international genetic parameters for calving traits (birth weight, calving ease) for Interbeef evaluations (§5) to the Interbull Centre.
- **Chris Murphy** (Chris Murphy Advisory PTY Ltd, Australia): Guidance and assistance for 2021 Annual Operational Planning (§2.5) and performing the Interbull Governance Review (§2.1).
- **Mike Goddard** (Agriculture Victoria Research, Australia): Scientific input into the implementation phase of the SNP Mace project (§9.2).
- **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 9 November 2021 to perform his first external audit for the new re-certification period (§3.2).
- Highschool students: **David Berglund** and **Oliver Widström** spent 4 weeks at the Centre under the supervision of Marcus Pedersen as part of a "school-work" program.
- **Tzayhri Osorio Gallardo** was an MSc student following the Erasmus Mundus EMABG (European Master in Animal Breeding and Genetics) program and attending her second year of the MSc at SLU. She joined the Interbull Centre to conduct her MSc thesis project from 16 November 2020 until 22 March 2021. The topic of her thesis project was: "*Assessing the benefits from joining the International beef cattle genetic evaluation (Interbeef) at SLU's Interbull Centre: Estonia as a case study*". Her supervisors were Simone Savoia and Alexis Michenet (Interbull Centre) and Birgit Zumbach (University of Göttingen), and her examiner was Erling Strandberg, SLU. Tzayhri successfully defended her thesis on 26 March 2021.

2. GOVERNANCE

2.1. Interbull Governance Review

A review of governance activities was commissioned by the Interbull Steering Committee in July 2021.

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.

Some aspects of governance were raised during the Interbull strategic planning meeting in January 2020 (Uppsala, Sweden). These issues were not specifically around the operations and performance of the organisation, but were more accurately categorized in two areas:

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

An independent consultant, Chris Murphy, was engaged to interview stakeholders, assess key documents (e.g., Terms of Reference¹, Rules of Procedure for Interbull Committees), and develop a report and recommendations in consultation with the Interbull Steering Committee and Interbull Centre Director. The Review was completed in December 2021. The outcomes of the review will be shared with the Interbull Community in 2022.

2.2. Interbull Steering Committee (SC)

Gordon Doak and **Enrico Santus** ended their (respectively 4 and 25 year) Interbull SC membership. Upon his retirement from the Interbull Steering Committee, Enrico received ICAR's "Outstanding Contribution Award".

During the Interbull Business Meeting on 29 April 2021, 5 candidates were proposed as Interbull Steering committee members, and subsequently endorsed by the ICAR Board during its meeting on 25 May 2021. These were, sitting members, **Matthew Shaffer**, **Brian Van Doormaal** and **Marija Klopčič**, and new members **Ezequiel Nicolazzi** and **Daniele Vicario**.

Whereas the term for Interbull SC membership is usually 4 years, the Interbull SC, with approval of the ICAR Chair, decided in 2020 on a variation in the term length, for implementation in the 2021 Business Meeting, in order to spread the end of the fixed terms more evenly. This resulted in the SC membership and terms as shown in Table 2.1

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.

Table 2.1: Interbull Steering Committee membership and terms (May 2021).

Name	Representing	(Re)elected	Term length	Term ends
Marija Klopčič	C&E Europe	2021	4	2025
Ezequiel Nicolazzi	North America	New: 2021	4	2025
Brian Van Doormaal	North America	2021	3	2024
Daniele Vicario	Italy, Spain & Portugal	New: 2021	3	2024
Gert Pedersen Aamand	Denmark, Finland, Sweden & Norway	2019	4	2023
Urs Schnyder	Germany, Austria, Switzerland	2019	4	2023
Gerben de Jong	UK, Netherlands, Ireland	2019	4	2023
Matthew Shaffer	Australia & New Zealand	2021	1	2022
Sophie Mattalia	France	2018	4	2022

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

2.3. Interbull Technical Committee (ITC)

Gert Pedersen Aamand chaired the ITC since 2010. Gert stepped down as the ITC Chair in April 2021, and the SC subsequently appointed Gerben de Jong as Chair of the ITC.

2.4. Interbull Scientific Advisory Committee (SAC)

During the reporting period, no changes took place to the composition of Interbull's SAC formed by Daniel Gianola, Ignacy Misztal, and Mike Goddard.

2.5. Interbull Centre 2021 and 2022 Annual Operating Plan

An Interbull Strategic Planning meeting was conducted in January 2020 in Uppsala (Sweden). The Interbull 2020-2023 Strategic plan² that resulted from this meeting identified 6 Key Goals, listed in Figure 2.1.

These six goals formed the basis for the development of the first **Interbull Centre Annual Operating Plan**, which included Interbull Centre's planned Service and R&D activities for Interbull, Interbeef, EU Reference Centre, and ICAR in 2021. The latest Annual Operating Plan (2022) is available on the Interbull website³.

Figure 2.1: 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

2.6. 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. During the period of this report, the BFMTF has mainly focused on SNPMap as a potential service delivered by the Interbull Centre.

2.7. New Traits Pipeline Working Group (NTP WG)

The Interbull SC appointed the NTP WG during the SC meeting of 10 December 2020. The NTP WG Terms of Reference were approved during the SC meeting of 16 February 2021. The creation of this WG, as well as its objectives and activities are in line with Key Goal 2 of the Interbull 2020-2023 Strategic Plan. The WG has created a framework that guides SC, ITC, Interbull Centre and Service Users in the decision process for introducing new traits and services in Interbull Centre portfolio. The framework will be presented in 2022.

2.8. 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.

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

³ <https://interbull.org/ib/itbcreports>

Interbull Code of Practice

The Interbull Code of Practice⁴ is updated on the basis of decisions by the Steering Committee. Notable updates in 2021 are:

- **Chapter 6, Traits and Breeds:** Adding specific information pertaining to the new “SNP Training for clinical mastitis” (“cma”) evaluation.
- **Chapter 10: Service fees:** Including information on how fees for novel traits, such as “cma”, will be calculated
- **Appendix I:** addition of the Letter of Understanding for “cma”.

Interbeef Code of Practice

The Interbeef Code of Practice, available through the ICAR website⁵, was updated in 2021, on the basis of decisions from the Interbeef Working group, notably:

- **Chapter 2, Services provided by Interbull Centre on Contract with ICAR:** better description of the services offered, in particular for the “Country Pilot run” Service.
- **Chapter 3, Pre-requisite for participation:** with clearer information on the steps needed in order to participate in an official evaluation.
- **Chapter 7, Data exchange and timing of evaluation:** with clearer information on the data provided by Interbull Centre to Organisations.
- **Chapter 8, Research projects:** with more detailed information regarding participants’ commitment, data security and anonymity for research,
- **Chapter 10, Service fee:** adding information on the Interbeef fee structure.
- **Chapter 11, Interbeef-WG and Technical Committee Meetings:** adding information on the principles defining the several working group’s meetings.

Together with the Interbeef Code of Practice, the “Interbeef Guidelines” have been reviewed and their content updated during 2021 with reference to specific information pertinent to the use of environmental effects in matter of both naming and length of values’ rules. The updated guidelines 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 have been applied to the GenoEx-PSE Code of Practice⁶ during 2021.

2.9. ICAR Guidelines

Interbull Guidelines (ICAR Guidelines Section 09)

The “Interbull Guidelines” (ICAR Guidelines’ “Section 09 – Dairy Cattle Genetic Evaluation”) were reviewed in April 2021 and are available on the ICAR website⁷. The review included information on sharing of genetic defects, sire categories, adjustment recommended for genomic reliabilities, and some recommendations for countries having a national evaluation based on single step model.

⁴ <http://www.interbull.org/ib/codeofpractice>

⁵ <https://www.icar.org/index.php/technical-bodies/working-groups/interbeef-working-group/>

⁶ https://interbull.org/ib/pse_cop

⁷ <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.

In 2021, the first official evaluations for SNP Training for clinical mastitis were performed, with the Test evaluation in January, and the Routine evaluation in April 2021.

GenoEx-GDE, for genotype data exchange, was used in January 2021 Test evaluation for the exchange of genotypes related to the InterGenomics (BSW) Service and is officially in use in Routine evaluations since April 2021.

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. Three organisations joined our services in 2021:

- Due to organisational restructuring, Croatia is now participating in Interbull evaluations through a new organisation: The Centre for Livestock Breeding (“HAPIH”).
- Italy and Estonia joined the Interbeef evaluations, for several breeds and traits, in October 2021.

Figure 3.1: Interbull's Global Reach (December 2021)



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 May 2021, Management, Services and Applied Research processes were reviewed by Emely van Rossem, and auditor within CRV (The Netherlands) with more than 20 years of experience in the field.

The external audit on 9 November 2021 was the first audit of the second re-certification period and, in line with Bureau Veritas' regulation, resulted in a new auditor. The re-certification 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. 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 WG 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 calendar⁸;
- Interbeef service calendar⁹.

⁸ <http://www.interbull.org/ib/servicecalendar>

⁹ <http://www.icar.org/index.php/technical-bodies/working-groups/interbeef-working-group>

4. SERVICE and OPERATIONS – 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/International genetic/genomic evaluations. The portfolio of validation methods offered by Interbull currently consists of five (5) different validation methods: four methods aimed at assessing the quality of conventional national evaluations, namely Method I, II, III and Mendelian Sampling Variance test and one assessing the quality of genomic national evaluations, GEBV test.

The Interbull Validation Working Group's work to define new validation procedures in the genomic area continues with the aim to provide new validation approaches for countries with national genomic evaluations in place. Such new methodologies would expand the current portfolio of validation methods.

4.2. MACE Evaluations

Tables 4.1 and 4.2 show statistics on Interbull MACE evaluations. Interbull Test evaluations were performed in January-February 2021 and September-October 2021. Many changes in national and international evaluations were introduced in 2021. All such changes are described in the service reports published on the Interbull Centre website, under MACE service reports¹⁰, after each subsequent routine evaluation.

The following changes in participation occurred during the official evaluations in 2021:

- PRODUCTION:
 - Croatia providing data via a new organisation (HAPIH) from April routine evaluation
 - Mexico no longer participating
- CONFORMATION:
 - Latvia participated for the first time with conformation traits for HOL and RDC from April routine evaluation
- UDDER HEALTH:
 - DEU RDC stopped participating to the MAS evaluation using SCS data as predictor for MAS, starting from the April routine evaluation
 - Croatia providing data via a new organisation (HAPIH) from the April routine evaluation
 - Slovak Republic in a joined evaluation with DEA and CZE for SIM from April routine run.
- LONGEVITY:
 - Japan participated for the first time with HOL data from the April evaluation.
- CALVING:
 - Poland participated for the first time with HOL data from the April evaluation
- WORKABILITY:
 - Spain, Poland and Czech Republic participated for the first time with HOL data from the April evaluation
- SNP Training for Clinical Mastitis “*cmā*”:
 - First official evaluation conducted in April routine run for three breeds (HOL, JER, BSW) and six countries (§8.1).

¹⁰ http://www.interbull.org/ib/maceev_archive

Table 4.1: Size of the Interbull Centre operations for MACE

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

Multiple Across Country Evaluation (MACE)	Sept 2019	Sept 2020	Sept 2021
Estimated across country genetic correlations	13 085	13 234	13 649
Validation tests (subject to natural fluctuations)	233	252	345

Table 4.2: Degree of Participation to MACE evaluations as for April 2021

	Prod (3)	Conf (up to 33)	Udder (2)	Long (1)	Calv (4)	Fert (5)	Work (2)	SNP Training (1)	Total (50)	2104r vs 2004r
BSW	11	9	10	10	6	9	7	2	64	+2
GUE	5	4	5	5	-	5	-	-	24	0
HOL	29	23	29	21	18	20	15	6	161	+10*
JER	12	10	10	9	-	9	6	2	58	+3
RDC	15	10	13	12	7	11	7	-	76	0
SIM	12	-	11	5	-	-	-	-	28	-1*
Tot	84	56	79	62	31	54	35	10	411	
Change	-1	0	0	+1	+1	0	+3	+10		+14

* Routine international genetic evaluations for Brown Swiss, Guernsey, Holstein, Jersey, Red Dairy Cattle and Simmental were computed as scheduled in April, August and December 2021.

TMACE evaluations were performed in October with current reduced data provided by the country-breeds-traits identified in Table 4.3.

Table 4.3: Country-breed-trait combinations in the October 2021 TMACE

Country	Breed	Trait	Organisation
DEA*	BSW	All	LFL+ZuchtData
USA	HOL, JER, BSW, GUE, RDC	All	CDCB
JPN	HOL	All	NLBC
ITA	HOL	Fertility, Mastitis	ANAFIBJ
CHE	BSW, HOL	All, excluding Mastitis	QUALITAS

+ DEA: Germany and Austria

4.3. 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 2021 and September-October 2021. GMACE Routine evaluations were performed in April, August and December 2021.

Table 4.4 - Size of the Interbull Centre operations for GMACE

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

+ 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 evaluations.

GMACE: Software Update

As reported in the Interbull Executive Summary¹¹ of December 2021, the GMACE software was reviewed, to improve rates of convergence, and to reduce computations so the program could be run longer. These changes were necessary to better align GMACE with published MACE proofs. Impacts were small for the evaluation scales of large populations, but in other cases the parent averages used in GMACE were very much improved, mainly for the scales of smaller populations with no national GEBV contributing to GMACE and relatively few locally proven bulls contributing to MACE.

4.4. InterGenomics: Interbull genomic evaluation of Brown Swiss and (small) Holstein populations.

Interbull Centre conducts 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.

The InterGenomics (BSW) evaluation process has been further improved by 1) enabling sharing of genotype information via the GenoEx-GDE platform and 2) further streamlined by implementing Version 3 of USDA’s Findhap¹² imputation software.

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

InterGenomics (Genomic evaluation of BSW populations)	Dec 2019	Dec 2020	Dec 2021
Countries	8	8	8
Country-trait combinations	280	280	375
Unique submitted genotypes	44 625	52 352	101 589
Genotypes entering imputation & genomic evaluation	36 791	41 665	59 156
Distributed international genomic estimated breeding values	10 301 760	11 666 480	13 785 838

InterGenomics countries: Canada, France, Germany, Austria, Italy, Slovenia, Switzerland, USA.

The first InterGenomics-Holstein Routine evaluation was performed in December 2020. This evaluation included data from four InterGenomics-Holstein Organisations, and three “Contributing Countries” (Germany, France and Denmark/Finland/Sweden), which contributed genotypes of proven Holstein sires with MACE proof for production traits towards the improvement/increase of the *InterGenomics-Holstein* reference population.

¹¹ <https://interbull.org/ib/executivesummary>

¹² <https://aipl.arsusda.gov/software/findhap/>

InterGenomics-Holstein Organisations:

- Irish Cattle Breeding Federation (ICBF) – Ireland
- Israel Cattle Breeders Association (ICBA) – Israel
- Slovenian Holstein Association (HOL-SLO) – Slovenia
- National Institute of Animal Science (NIAS) – South Korea

In 2021 a new version of the InterGenomics-Holstein Agreement¹³ was signed and the service was enhanced so that those “Contributing Countries”, which provide genotypes of young bulls in AI on an ongoing basis (currently Germany only), can better identify young bulls to be marketed in the InterGenomics-Holstein Countries. Starting from the December 2021 routine evaluation, “Contributing Countries” of young bull genotypes are provided with TMI computed at the national level by each InterGenomics-Holstein Organisation (using gEBVs from the InterGenomics-Holstein Service) for the Contributor-owned young bulls.

Table 4.6: Size of the Interbull Centre operations for InterGenomics-Holstein

InterGenomics-Holstein (Genomic evaluation of small Holstein populations)	Dec 2021
Countries	4
Country-trait combinations	95
Unique submitted genotypes	40 354
Genotypes entering imputation & genomic evaluation	12 828
Distributed international genomic estimated breeding values	813 718

InterGenomics-Holstein countries: Ireland, Israel, Slovenia, South Korea.

¹³ https://interbull.org/ib/ig_hol_letter_agreement

5. SERVICES and OPERATIONS – International Beef Evaluations (Interbeef)

Interbeef routine evaluations were performed, as scheduled, in January and October, and includes 15 countries. The distribution of Interbeef results across breeds, traits and countries is reported in Table 5.1.



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

Interbeef breeding values are estimated using MiX99 Software. Reliabilities are calculated using the MTEDC5 package. Variance components for aww and carcass traits (cco, cfa, and cwe) are estimated by ICBF (Ireland) using the DMU package, while variance components for calving traits (bwt and cae) are estimated by CMBC (Czech Republic) using the BLUPF90 package.

Interbeef – new countries

In the October 2021 Routine evaluation, 2 countries joined the Interbeef Routine Service for the first time:

- Italy (ITA), with adjusted weaning weight (aww) for the Charolais and Limousin breeds;
- Estonia (EST), with aww and calving ease (cae) for Aberdeen Angus, Charolais, Hereford and Limousin.

Interbeef Calving Traits – additional breed*trait evaluations

Calving traits evaluations for Aberdeen Angus and Hereford breeds were incorporated in routine evaluations in October 2021, involving Czech Republic, Denmark, Estonia, Finland, Ireland and Sweden.

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

	Adjusted Weaning Weight (aww)					Birth Weight (bwt)					Calving Ease (cae)					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
South Africa		✓					✓									2
Switzerland	✓	✓	✓	✓	✓											5
Total	6	12	6	12	5	3	6	3	6	3	4	6	4	7	3	86

+ DFS: Denmark, Finland, and Sweden

Table 5.2: Size of the Interbull Centre operations for Interbeef

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

* Direct + maternal EBVs are counted as one.

Interbeef Carcass Traits

Carcass traits evaluations were performed for the first time during the April 2021 Interbeef Test evaluation for the following traits: carcass weight (cwe), carcass conformation score (cco) and carcass fat (cfa) for Charolais, Limousin and Simmental breeds. Variance components were estimated by ICBF (Ireland) using the DMU package.

Countries participating in the evaluation (Denmark, Finland, Ireland, Sweden, and Switzerland) expressed their preference to perform additional investigations before moving to a routine implementation.

6. DATA EXCHANGE SERVICES – Interbull Centre

The Interbull Centre provides three levels of genetic and genomic data exchange (Table 6.1).

The International Genotype Exchange Platform (“GenoEx”) is a platform for exchanging genotypes in a standardised way through which the Interbull Centre facilitates the exchange of Parentage SNP data (GenoEx-PSE) and -large- genotypes (GenoEx-GDE). The exchange of information on recessive traits takes place through the “AnimInfo” module, within the Interbull Data Exchange Area (IDEA).

Participation for each of these services (December 2021) is provided in Table 6.2.

Table 6.1: Interbull Centre genetic and genomic data exchange services

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.	AI bull owners have more accurate identities of daughters in semen importing countries.
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.
Recessive Traits	IDEA-AnimInfo	Sharing of updated information regarding recessive traits. Identify AI bulls which are carriers of important recessive traits.	Recessive Trait information on animals tested in other countries becomes available to all participating organisations.

Table 6.2: Participation in genetic and genomic data exchange services (December 2021)

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	✓		
Italy	ANAPRI	✓		
	ANARB		✓	
	ANAFIJ	✓		
Japan	LIA	✓		
Netherlands	CRV			✓
Norway	GENO	✓		
Poland	NRIAP	✓		
Slovenia	AIS	✓	✓	
Switzerland	Qualitas		✓	✓

+ DFS: Denmark, Finland, Sweden

6.1. Parentage SNP Exchange

Parentage SNP Exchange takes place through Interbull Centre’s International Genotype Exchange Platform (GenoEx). GenoEx-PSE is available for any dairy and beef breed.



ICAR accreditation for DNA data interpretation is an important prerequisite for participation in the PSE service. Further details, including User Manual, Code of Practice and Service User Agreement are available on the GenoEx website¹⁴.

¹⁴ GenoEx.org

6.2. Genotype Exchange

GenoEx-GDE (Genomic Data Exchange) builds on GenoEx, providing an easy way for exchanging large genotypes datasets, facilitating building reference populations, decreasing costs by avoiding re-genotyping the same individuals and encouraging development of genomic evaluation.

Following the release of the beta version in August 2020, and positive feedback from the InterGenomics BSW community, GenoEx-GDE was officially released ahead of the January 2021 InterGenomics Test evaluation. The support program “gxprep.py” - aimed at converting the genotypes files in a compatible format to be uploaded on GenoEx-GDE - was released at the same time.

The BSW Organisations, with support from Interbull Centre, uploaded on GenoEx-GDE all their historical genotypes previously submitted for the InterGenomics Service using the 705 file format. Interbull Centre verified the consistency of the submitted genotypes and scheduled the full implementation of GenoEx-GDE for the genotypes exchange starting from the 2021 InterGenomics April routine run.

During 2021, the Interbull Centre continued to work towards enhancing GenoEx-GDE users’ experiences by developing high-priority web interface features.

6.3. Exchange of Information on Genetic Recessive Traits

The exchange of information on genetic recessive traits takes place via the AnimInfo module of the Interbull Data Exchange Area (“IDEA”). The service is in place for sharing of specific genetic traits in the Holstein breed (WHFF Genetic traits). Interbull Centre is working with the ICAR “Breed Associations” and “Interbeef” Working Groups to expand the service to beef cattle, while we also welcome additional dairy breeds.

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.



Within this context is the validation of national EBVs and GEBVs one of the top priorities to ensure reliable National/International genetic/genomic evaluations. Conventional Validation tests provide reassurance to the National Genetic Evaluation Centres, cattle organizations and farmers that the bias in their statistical models applied for a given breed/trait are within a tolerated threshold of 2%. This is an assurance that their statistical models applied are sound and fit well their data avoiding any under/over estimation of their animals' genetic worth. In 2021 the Interbull Centre provided 345 conventional and 230 genomic validation tests to National Genetic Evaluation Centres.

7.1. EURC Performance Recording, Evaluation & Publication Database

In its function as the EU Reference Centre, and in order to harmonise and standardise performance recording and evaluations, the Interbull Centre is expanding its service to collect and provide information from breeds, populations and evaluation systems. Interbull Service Users and National Genetic Evaluations Centres are acquainted with Forms "GE", "GENO" and "BEEF" to describe their national systems for performance recording and genetic & genomic evaluation that is already well within EU reference centre interest. The Interbull Centre's current information system for performance testing and genetic evaluations will be updated to make it scalable and efficient in dealing with and sharing of information from an increased number of organisations. It has therefore developed a database that enables the collection of additional information, and harmonisation of the information to make it comparable between organisations: EURC's Performance Recording, Evaluation and Publication ("PREP") Database.

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 an effort to better compare and ultimately harmonise performance testing and genetic evaluation methodologies. The type of information collected includes:

- Meta information on breeding "chain" (countries, organisations and populations)
- trait definition used (specifications, or e.g. ICAR standards)
- time periods for data collection and analysis
- processing and statistical procedures (levels for details).

During 2021, Interbull Centre has evaluated information from the GE forms that have been submitted by all National Genetic Evaluation Centres for dairy production and calving traits. This work enabled the development of standardised expressions used in the forms for these traits. The standardised expressions are fundamental in the incorporation of the information from the GE forms into the PREP database. The PREP database will become available to the Interbull Community during 2022.

Aided by the standardisation of trait information in the PREP database, Interbull Centre finalised the first version of recommended guidelines for recording, editing and evaluating calving traits in dairy cattle, in order to harmonise records and evaluations of calving traits across countries. This first version of the recommendations will be reviewed by the Interbull Technical Committee, with the expectation to be finalised in 2022.

8. OTHER, NEW and IMPROVED SERVICES – Interbull Centre

8.1. New MACE evaluation: SNP Training for Clinical Mastitis (“cma”)

The mastitis (*mas*) evaluations that have been performed in recent years, combining SCS and (sub-) clinical mastitis information, had lately brought up two main arguments towards the possibility to have a dedicated clinical mastitis (“cma”) evaluation: 1) low correlations for national bulls between national and MACE proofs and 2) the need, in the genomic era, to have a foreign reference population for clinical mastitis not affected by the presence of SCS data.

Several pilot investigations conducted during 2020 led to the first official test and routine evaluations for *cma* in respectively January and April 2021. Table 8.1 presents the countries/breeds which submitted specific *cma* data to the Routine evaluations. The *cma* evaluation serves as a SNP training tool for mastitis for countries with national genomic evaluation while the current *mas* evaluation will remain the official international evaluation for publication purposes. Results from *cma* evaluations may therefore not be used for publication purposes.

Table 8.1: Countries per evaluated breed providing data for the first *cma* Routine evaluation in April 2021.

Country	Breed			Total
	HOL	JER	BSW	
CHE	✓		✓	2
CAN	✓	✓		2
DEU	✓			1
FRA	✓		✓	2
NLD	✓			1
USA	✓	✓		2
Total	6	2	2	10

8.2. Review of MACE Post Processing Windows

According to the established procedures, estimated correlations are required to fall within certain windows’ values. For milk production traits, for example, separate windows are maintained depending on the climate and whether countries predominantly have grazing systems. Two countries with a similar climate and production system (grazing vs. non-grazing) are expected to be more correlated with each other than two countries with different climates or production systems. If estimated correlations are lower than the window’s minimum value, they are set equal to the window’s minimum value specified for that given group. In addition, estimates are regressed towards a mean correlation within groups, the regression depending on the number of common bulls.

Such windows’ values were last reviewed during the 2015 Interbull Meeting, with the ITC recommendation to review every 5 years. In line with this recommendation, the original WG was reactivated in January 2020.

The window’s minimum values adopted over the past five years (based on the 25th percentile) were found too high, causing estimated and post-processed correlations to differ significantly from each other. The window’s minimum values have therefore been reduced to the 10th percentile. This reduction is expected to provide post-processed correlations which will be closer to the real estimated ones. The upper values were judged to have very little effect on evaluations and remain 0.99.

The weights assigned to the magnitude of changes tested by each country were also revised. The new weights (see Table 8.2) will allow post-processed correlations to be closer to the value of the newly estimated ones, even when no changes are applied by the countries. The revised post-processing procedures were introduced during the January 2021 test run and applied to all breeds and traits. More information can be found on Interbull procedure¹⁵.

Table 8.2: Post processing weights

Type of Change	Weight
No changes between Country _{1,2}	2
Small changes between Country _{1,2}	1
Big changes between Country _{1,2}	0

¹⁵ https://interbull.org/ib/rg_procedure

8.3. 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.

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 the necessary test files and checking the results. The test files are created by a programme, 'Cuckoo', that has been developed by Lactanet, Canada.

Until December 2021, twenty-four organisations have completed the test and are now recognised as ICAR Accredited DNA Data Interpretation Centres (see ICAR DNA list¹⁶ 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 website¹⁷ for further info.

ICAR Certificate of Quality

The Interbull Centre provides ICAR with information on international genetic and genomics evaluations for the ICAR Certificate of Quality. During 2021, information was provided for two Interbull Service Users: vit (Germany) and Geno (Norway).



¹⁶ <http://tiny.cc/ICARDNAlist>

¹⁷ 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 2021.

9.1. SNPmace; International SNP Evaluations

In the SNPmace Feasibility Study, breeding values were estimated using the SNPmace methodology and compared to those obtained from a multi-trait international genomic evaluation using genotypes. Results of the study showed that combining the SNP solutions from several populations gave the same result as combining the raw data. This means that more accurate SNP solutions, and hence more accurate genomic EBVs, can be achieved by 1) first analysing training population within a country and then 2) combining the SNP solutions from a range of countries – without the exchange of genotypes.

A. Jighly and M. Goddard (Agriculture Victoria, Melbourne) developed an efficient software (“MetaGS”) to run the SNPmace model, which has been tested at the Interbull Centre. In addition, the software to be run by national genetic evaluation centres (to create SNPmace input data) was successfully tested by several Interbull users. Software’s manuals and guidance for potential SNPmace Service users have been completed.

Following an initial data call to a SNPmace pilot run, questions regarding the Business Model and Service agreement were raised. Considering the significant differences between the current Interbull services and the envisaged SNPmace service, Interbull organised a SNPmace Consultation Webinar and Survey in November 2021, during which such questions were addressed.

A total of 64 participants joined the webinar which focused on describing the principles of the Business Model envisaged for a potential SNPmace Service and informed the participants on the upcoming survey. The SNPmace Consultation Survey was issued in November 2021. The outcomes of the survey will guide Interbull in the next steps to be taken (in 2022) prior to offering the Interbull community a potential new service based on the SNPmace method.

9.2. Genomic Reliabilities (“GREL”) WG

Before 2021, one single formula has been introduced to calculate the DGV reliabilities (GREL) for all reference animals, taking into consideration the data contribution of both bulls and cows. However, the effect of the change of cow reliabilities calculation on candidates remained to be investigated. In 2021 the Genomic Reliabilities Working Group:

- Tested the Interbull GREL method for single-step genomic evaluation and is currently checking the effect of the change in the formulae on candidate genomic reliability values.
- Provided guidance for the implementation of the Interbull GREL methodology in the InterGenomics-Holstein service.

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

Following the development of simulation methods for Genomic Pre-selection (GPS) scenarios relevant to MACE, and a review of the potential approaches to increase MACE robustness to GPS bias, the WG has continued, in the current reporting period, developing new MACE software which will account for GPS effects on the distributions of breeding values over time.

9.4. Genomic-free EBV WG

On 11 February 2021, the Interbull Centre organised a dedicated webinar to provide recommendations on “Genomic-free EBV for MACE” to the over 100 registrants. During the webinar, chaired by Gert Pedersen Aamand (Genomic-free EBV WG chair) it was explained that the activity of the “Genomic-free EBV” WG was aimed at identifying new solutions to produce genomic-free EBVs that could be used as input for the MACE evaluation. Pete Sullivan presented the Genomic-free EBV WG recommendations. After an interesting discussion all participants agreed on the solutions identified by the WG and no objections were raised. Some of these (short-term) solutions can be implemented by NGECS, while Interbull Centre is working (in Future MACE) on some of the (longer-term) solutions. With this webinar, the task of the Genomic-free EBV WG is completed, and the WG has been disbanded.

9.5. Validation WG

The Validation Working Group met several times during 2021, making progress on identifying possible new regression tests in order to identify bias due to genomic pre-selection.

10. RESEARCH & DEVELOPMENT – Beef

10.1. Interbeef Carcass traits evaluation

During the January Interbeef-WG and Technical Committee meeting, participating countries (Denmark, Finland, Ireland, Sweden and Switzerland) agreed on submitting new data (using IDEA database) for the Interbeef April test run, for:

Traits: Carcass weight (cwe), Carcass conformation (cco) and Carcass fat (cfa).

Breeds: Charolais, Limousin and Simmental.

The Interbeef evaluation workflow has been thoroughly reviewed and streamlined so that this new trait group can be evaluated within the routinely evaluated traits.

Carcass traits' variance components parameters were estimated by ICBF (Ireland) and used by Interbull Centre in the April 2021 Interbeef Test evaluation.

After reviewing the results from the test evaluation, the participating countries expressed their preference to go through additional investigations before moving toward a routine implementation. During the December 2021 Interbeef-WG and Technical Committee meeting, UK expressed interest in a possible future participation in the carcass traits evaluation and it has, since then, been involved in the related R&D activities.

10.2. Interbeef Female Fertility traits WG

Romain Saintilan (GenEval, FRA) and Wolfgang Ruten (vit, DEU) worked on an agreement for trait definition and data consistency among countries. During the January 2021 Interbeef-WG and Technical Committee meeting, participants agreed on a data call aimed at collecting data in parallel with the Interbeef April test run. Pedigree information has been uploaded to the IDEA database while for performance data, flat files were used. The data call focused on 2 traits: number of calving (nca) and calving interval (cai). R&D activities continued during the whole of 2021.

10.3. Validation of national and international beef models WG

Throughout the whole period of this report, the Interbeef Validation WG continued its activities towards developing validation methods of national and international beef models, focusing on addressing different needs in different countries' scenarios.

10.4. Variance Component WG

The Variance Component WG discussed about the possibility of changing the format of files used for exchanging parameters between Interbull Centre and Consultants. Outcomes of the discussions will be considered for future improvement of information exchange.

10.5. Interbeef Information exchange WG

The Interbeef Information exchange WG has been constituted 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. The WG had the kick-off meeting in December 2021.

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 data exchange: Interbull **Data Exchange Area** (“IDEA”) and International **Genotype Exchange Platform** (“GenoEx”), 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.

System Maintenance, Development and Security

During 2021, system administration focused particularly on the following areas:

- Updating of systems and operating systems.
- Upgrading servers to Debian Bullseye released in the autumn of 2021
- Setting up, configuring and testing an initial system of SLURM
- Implementing redundancy for specific servers, to maximize uptime and minimize downtime at disaster recovery
- Converted SAS scripts to python with the help of a consultant, to remove any unnecessary dependency to other servers and to improve security.

The Interbull FTP-server was updated in 2021: older versions of the ssh protocol have become obsolete and will no longer be used for security reasons. Organisations experiencing trouble connecting to Interbull servers, should consider upgrading their client software used, to be able to comply with only secure versions of the ssh protocol.

Checking programs: Upgrade from Python2 to Python3

During 2021, Interbull Centre staff actively worked on upgrading all available checking programs from Python2 to Python3. The upgrade was deemed necessary as Python2 reached end of life and will no longer be supported by developers.

The Interbull Centre’s Python upgrade has been completed, and all Service Users and National Genetic Evaluation Centres have been strongly advised to upgrade to Python3 (minimum 3.6) in order to minimise potential issues.

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.

Interbull Centre's involvement in the following international consortia focuses on providing services to the project (enabling international exchange of data; quality control), and on developing services to the Interbull Community (several of whom are involved in the projects), in line with the Interbull 2020-2023 Strategic Plan.

12.1. GenTORE



GenTORE

Project title: *Genomic management tools to optimise resilience and efficiency*

Project Period: 1 June 2017 – 31 May 2022 (60 months)

Funding source: European Commission; Horizon2020, Research and Innovation action

Website: GenTORE¹⁸ or interbull/gentore¹⁹

Twitter: @GenTORE_2020

One of GenTORE's aims is to develop new evaluations for traits related to efficiency and resilience. **"Age at Slaughter"** has been identified as a proxy for resilience. Organisations involved in Interbeef have relevant data available. Interbeef partners have started with analysis of age at slaughter and carcass data in order to develop international breeding value estimations through Interbeef for such traits.

Interbull Centre has collected and stored performance data from Interbeef members (Denmark, Finland, Ireland, Sweden, and Switzerland) on "Age at slaughter" for Charolais, Limousin and Beef Simmental breeds in the IDEA Performance Database.

The Interbull Centre reviewed, as part of GenTORE activity, the Interbeef workflow to enable the incorporation of traits such as "Age at Slaughter". Variance components for Age at slaughter were estimated by ICBF (Ireland) and used by the Interbull Centre in a preliminary international evaluation for such trait. Evaluation results were distributed to participating countries in October 2021.

The results of the international evaluation on "Age at Slaughter" performed by the Interbull Centre, using data from Interbeef partners, were presented during the latest GenTORE Annual meeting (November 2021, Padua - Italy) in the context of *"Genomic indices for multi-breed selection in different environments"*.

12.2. ReDiverse

The European Union-funded "ReDiverse" project *"Biodiversity Within and Between European Red Dairy Breeds - Conservation through Utilization"* finished in 2021. The main purpose of this project was to establish collaborative and integrated novel breeding and management concepts to achieve a resilient and competitive use of these resources and to strengthen best practices for small farm holders for improving product quality and to supply ecosystem services according to their specific circumstances. An investigation in the population structure and genetic connectedness as well as phenotype recording schemes for the European Red Dairy Cattle breeds was carried out as part of the project and mostly

¹⁸ www.GenTORE.eu

¹⁹ www.interbull.org/ib/gentore

based on Interbull's Genetic Evaluations Forms. The results of this investigation are available on the Interbull website²⁰. The project also led to a manuscript with the title of *"Inbreeding and pedigree analysis of the European Red Dairy Cattle"* which has been submitted to Genetics Selection Evolution journal.

12.3. International Genetic and Genomic Evaluations of Beef Cattle

Project Period: 1 May 2018 – 1 May 2022 (48 months)

Funding source: ICBF, ICAR, Interbull

PhD Project carried out by PhD Candidate Renzo Bonifazi. The aim of this research is to investigate some of the upcoming challenges in international beef evaluations. During 2021, the Interbull Centre supported Renzo in data interpretation for the key objective of his study in 2021: *"Which is the most appropriate genomic model for beef cattle international evaluations and how much gain in term of genomic reliability can be achieved through international cooperation?"*

Following the interest raised by Interbeef members in results from this PhD study, discussions started in the Interbeef WG on how to move towards a new Interbeef service based on genomic information.

²⁰ https://interbull.org/ib/rediverse_phenotypic_report

13. MEETINGS, COMMUNICATIONS and PUBLICATIONS

13.1. 2021 Interbull Annual Meeting

Due to the ongoing risks of the Covid-19 pandemic, the 2021 ICAR Interbull Meeting was held as a hybrid meeting, from April 26 to April 30 2021. The main venue was the World Trade Centre in Leeuwarden, The Netherlands. A total of 513 people registered for the ICAR-Interbull meeting, of which the majority attended online. One hundred and thirty-two people attended the **Interbull Business Meeting** online. Public materials for the Business Meeting are available on the Interbull website²¹.



The five **Interbull Open Meetings** attracted each between 141 and 166 online attendees. Power point presentations of the **Open Meetings** are available on the Interbull website²², while the papers of these presentations have been published in Interbull Bulletin No. 56.

Feedback from the Interbull Community shows that the meeting was well appreciated. Pre-recorded videos of speakers were greatly appreciated. The setup of the meeting was found very well usable for future virtual meetings.

13.2. Future Interbull Annual Meetings

Upcoming Interbull Annual Meetings have been scheduled as follows:

2022: Joint ICAR-Interbull Meeting in Montreal, Canada from 28 May-3 June 2022.

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

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

13.3. Interbull Bulletin and Website

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 2021 virtual Interbull Meeting were published in Interbull Bulletin No. 56 in September 2021. This issue as well as back issues can be accessed through the Interbull Bulletin website²³.

The **Interbull**²⁴ and **GenoEx**²⁵ websites have been updated with the latest information, including the 2021 Interbull Centre Activity and Finance Reports, and Strategic and Annual Operating Plans²⁶.

The latest information on **Interbeef** is shared with ICAR so relevant Interbeef pages on the ICAR website²⁷ can be updated.

Pictures of Interbull events remain available in the “**Hall of Fame**”²⁸.

13.4. Publications by Interbull Centre staff

Simone Savoia, 2021. Interbull genomic evaluation of small Holstein populations: InterGenomics-Holstein (IG-HOL), Interbull Bulletin 56, p180-187.

<https://journal.interbull.org/index.php/ib/article/view/63/63>

²¹ https://interbull.org/ib/business_meeting_2021

²² https://interbull.org/ib/programme_virtual_2021

²³ <https://journal.interbull.org/>

²⁴ www.interbull.org

²⁵ <https://GenoEx.org>

²⁶ <http://interbull.org/ib/itbcreports>

²⁷ <https://www.icar.org/index.php/technical-bodies/working-groups/interbeef-working-group/>

²⁸ <http://interbull30years.blogspot.se/>

Appendix 1: Interbull and Interbeef- WGs and TF compositions (31 December 2021).

Interbull Centre personnel is represented in various Committees, Task Forces and Working Groups. Full membership for these groups is provided below. Within brackets are members of the Interbull Centre team who regularly attend the meetings of the group, even if not official group member.

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:**
Brian Van Doormaal (Chair), André Eggen, Suzanne Harding, Dariusz Kamola, Michael Keane, Sandra Kipp, Raffaele Mazza, Matthew McClure, Romy Morrin-O'Donnell, Nilesh Nayee, Ezequiel Nicolazzi, **Joanna Sendeka**, Wim van Haeringen, Jiansheng Qiu, Hiemke Knijn, 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, Simone Savoia, 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), Gerrit Kistemaker, Tom Lawlor, Paul VanRaden, Zengting Liu, Raphael Mrode, Esa Mäntysaari, Peter Sullivan, **Simone Savoia (Valentina Palucci, Katrine Haugaard, Fernando Macedo)**.
- **Interbull Scientific Advisory Committee:**
Mike Goddard, Daniel Gianola, Ignacy Misztal.
- **EU Reference Centre WG:**
Sophie Mattalia (Chair), Marija Klopčič, **Toine Roozen, Joanna Sendeka, Valentina Palucci**.
- **Business Funding Models Task Force:**
Brian Van Doormaal (Chair), Matthew Shaffer, Sophie Mattalia, Urs Schnyder, Gert Pedersen Aamand, **Toine Roozen**.
- **InterGenomic-Holstein WG:**
Marija Klopčič (Chair), Sophie Mattalia, Brian Van Doormaal, **Toine Roozen, Simone Savoia**.
- **New Traits Pipeline WG:**
Gerben de Jong, Ezequiel Nicolazzi, **Toine Roozen, Valentina Palucci**.

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**.
- **Validation WG:**
Esa Mäntysaari (Chair), Zengting Liu, Paul VanRaden, Pete Sullivan, Raphael Mrode, **Valentina Palucci**.
- **SNPMace WG:**
Enrico Santus (Chair), Mike Goddard, Vincent Ducrocq, Esa Mäntysaari, Zengting Liu, **Simone Savoia**.
Work is carried out by Abdulqader Jighly (Victoria Agriculture), **Simone Savoia** (Interbull Centre).
- **Genomic free EBV WG (dissolved February 2021):**
Gert Pedersen Aamand (Chair), Gerben de Jong, **Pete Sullivan**, Paul Van Raden, Mike Goddard, Esa Mäntysaari, Zengting Liu, **Simone Savoia**.
- **Post processing of MACE correlations WG (dissolved February 2021):**
Raphael Mrode (Chair), Zengting Liu, Paul VanRaden, Tom Lawlor, **Valentina Palucci**.

Interbeef Working Groups:

- **Interbeef Technical Committee:**
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, **Simone Savoia (Toine Roozen)**.
- **Interbeef Validation WG:**
Ross Evans (Chair), Thierry Pabiou, Romain Saintilan, Stefano Biffani, Dorian Garrick, Roel Veerkamp, Esa Mäntysaari, **Fernando Macedo**.
- **Interbeef VCE WG:**
Thierry Pabiou (Chair), Wolfgang Ruten, Zdenka Vesela, Sophie Kunz, **Simone Savoia**.
- **Interbeef Female Fertility WG:**
Wolfgang Ruten (Chair), Nicolas Frioni, Dierck Segelke, Romain Saintilan, Thierry Pabiou, Sophie Kunz, Stefano Biffani, **Simone Savoia**.
- **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**.
- **Advisory Committee for the PhD Project "International Genetic and Genomic Evaluations of Beef Cattle" by Renzo Bonifazi:**
Roel Veerkamp (Promotor), Mario Calus, Jeremie VandenPlas, Jan ten Napel, Ross Evans, Martino Cassandro, Emiliano Lasagna, **Simone Savoia**.

Appendix 2: Interbull Centre Staff: Training, Courses, Meetings and Conferences (2021)

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 App2.1-5.

Table App2.1: Provision of training during 2021

Courses provided:	Dates 2021	Person
"Genomic-free EBV for MACE"	11 February	Pete Sullivan
ANAFIBJ - online webinar	3 March	Simone Savoia
Seminar in International breeding evaluation during course in Animal breeding and genetics (Universita' degli studi di Perugia, IT)	10 May	Valentina Palucci
ANARB- online webinar	28 October	Simone Savoia, Valentina Palucci
Course on International evaluation and Interbull activities (Lecture in Animalieproduktion – idisslare)	24 November	Valentina Palucci
Seminar in International evaluations performed by Interbull Centre (Universita' degli studi di Perugia, IT)	9 December	Simone Savoia
Course on Beef cattle breeding (Lecture in Animalieproduktion – idisslare)	10 December	Katrine Haugaard

Table App2.2: Attendance of events during 2021

Event	Dates 2021	Attendee
Meeting with European Competent Authorities	12-13 January	Toine Roozen, Valentina Palucci, Joanna Sendeka
Interbull webinar "Genomic-free EBV for MACE"	11 February	Valentina Palucci, Simone Savoia, Joanna Sendeka, Alexis Michenet, Toine Roozen
Eurogenetics meeting (online)	18 March	Simone Savoia
Libre Planet 2021	20-21 March	Marcus Pedersén
"MyICAR"	24 March	Toine Roozen
2021 Interbull Virtual Open Meeting	26-30 April	Toine Roozen, Valentina Palucci, Simone Savoia, Joanna Sendeka
2021 Interbull Virtual business Meeting	29 April	Toine Roozen, Valentina Palucci, Simone Savoia, Joanna Sendeka
2021 Animal Identification WG Virtual meeting	27 April	Valentina Palucci
GenTORE WP4 meeting	11 May	Simone Savoia
Interbull SNP Mace Webinar	26 May 24 November	Simone Savoia, Valentina Palucci, Toine Roozen
Interbull Centre internal audit	28 May	Toine Roozen, Simone Savoia, Joanna Sendeka, Valentina Palucci
How did Brian Wickham change the world (of cattle breeding)?	26 July	Toine Roozen, Valentina Palucci, Simone Savoia, Katrine Haugaard, Fernando Macedo, Joanna Sendeka
DebConf21	24-28 August	Marcus Pedersén
Meeting with French Competent Authority	7 September	Joanna Sendeka, Valentina Palucci
EU Refence Centres/Laboratories Directors mtg	18 October	Toine Roozen
Eurogenetics meeting (Amsterdam)	25-26 October	Simone Savoia
ISO 9001 Re-certification audit	9 November	Valentina Palucci, Simone Savoia, Toine Roozen, Joanna Sendeka, Marcus Pedersen
GenTORE 4 th annual meeting (Padova)	15-17 November	Simone Savoia
Seminar in Cattle Breeding (SLU - HGEN)	10 December	Simone Savoia, Valentina Palucci

Table App2.3: Interbull Meetings; 2021

Committee	Dates 2021	Attendee
Steering Committee	16 February 24 March 5 May 3 June 9 September 23 November 9 December	Toine Roozen, Valentina Palucci
Technical Committee	13 April	Simone Savoia, Toine Roozen, Valentina Palucci
	27 May	Fernando Macedo, Simone Savoia, Toine Roozen, Valentina Palucci
	23 November	Fernando Macedo, Katrine Haugaard, Simone Savoia, Valentina Palucci
Reporting to Steering Committee:		
SNPMace WG	9 February 16 March 26 May 11 June	Simone Savoia, Toine Roozen
InterGenomics Holstein WG	17 August	Simone Savoia, Toine Roozen
Business Funding Models TF (BFMTF)	9, 28 June 19 July 19 August 30 September 20 October 17 November	Toine Roozen, Simone Savoia
New Traits Pipeline (NTP) WG	2 June 8, 15, 21 July 4, 12 August 2 September 14 October 10 November 17 December	Valentina Palucci, Toine Roozen
EU Reference Centre WG	25 February 17 March 3 May	Joanna Sendecka, Valentina Palucci, Toine Roozen
Reporting to Interbull Technical Committee:		
Validation WG	1 April 1 November	Valentina Palucci

Table App2.4: Meetings related to Interbeef by Conference call; 2021

Group	Dates 2021	Attendee
Interbeef Working Group	28 January	Alexis Michenet, Simone Savoia, Toine Roozen
	24 March	Simone Savoia, Toine Roozen, Valentina Palucci
	25 May	Fernando Macedo, Simone Savoia, Toine Roozen, Valentina Palucci
	13 July 23 September 2 December	Fernando Macedo, Katrine Haugaard, Simone Savoia, Toine Roozen, Valentina Palucci
Interbeef Technical Committee	28 January	Alexis Michenet, Simone Savoia, Toine Roozen
	24 March	Simone Savoia, Valentina Palucci
	25 May	Fernando Macedo, Simone Savoia, Valentina Palucci
	13 July 23 September 2 December	Katrine Haugaard, Fernando Macedo, Simone Savoia, Toine Roozen, Valentina Palucci
Interbeef Chairs meeting	14 January	Alexis Michenet, Toine Roozen, Simone Savoia
	5 May 2 June 7 July 11 August 8 September 6 October 3 November	Toine Roozen, Simone Savoia, Valentina Palucci
Validation WG	24 May 4 June 28 July 5 October 5 November	Fernando Macedo, Simone Savoia, Valentina Palucci
Female Fertility WG	19 January 29 November	Simone Savoia
Carcass Evaluation WG	27 July 3 August 2 November 18 November	Simone Savoia
Interbeef Genomic Task Force	2 September 14 October 25 November	Simone Savoia
Interbeef Data Exchange WG	6 September 26 October 9 December	Simone Savoia, Toine Roozen Valentina Palucci
GE Form WG	14 October	Simone Savoia
Semestral supervisory meeting Renzo Bonifazi's PhD	23 March 1 October 3 March 2022	Simone Savoia
Variance Component Estimation WG	11 February	Alexis Michenet, Simone Savoia

Table App2.5: Meetings related to ICAR Committees, Working Groups and Task Forces; by Conference call; 2021

Group	Dates 2021	Attendee
Reporting to ICAR:		
ICAR-Interbull I2021 LOC and Programme committees	8, 20 January 5 February 5,12,19,26 March 1, 9,15 April 10, 21 May	Toine Roozen and/or Valentina Palucci
ICAR-Interbull 2022 LOC	11 January 8 February 8 March 12 April 10 May 10 June 7 July 09 September 12 October 22 November 10 December	Valentina Palucci and/or Toine Roozen
ICAR ID-Subcommittee	15 March 19 October	Valentina Palucci
ICAR Breed Associates WG (subgroup: Beef Traits)	14 April 18 October	Valentina Palucci
ICAR DNA WG	15 April 15 June 28 September 2 November	Joanna Sendeck
BIF & ICAR	27 April 26 May 19 July 21 October 11 November 16 December	Valentina Palucci
ICAR Board & Chairs	8 June 9 November	Toine Roozen