SEGES INNOVATION

STØTTET AF
Mælkeafgiftsfonden

Analysis of Birth traits

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Introduction

The birth index for a bull is a measure of the genetic potential of his offspring to have an easy birth (direct effect). We use six traits to calculate this index:

1. Still birth, early
2. Calving ease, early
3. Calf size, early
4. Still birth, later
5. Calving ease, later
6. Calf size, later

Still birth is binary trait indicating whether a calf is stillborn. Calving ease and calf size are subjective judgements made by the farmers after birth. The traits are divided into early period (birth from a heifer) and later period (birth from a cow), since births are usually easier later in a cows life.

The model and genetic parameters are the same as those used in the current official NAV evaluation. For each breeds evaluation, we only use phenotypic data from animals with the correct breed in their `id_nor`. We also only include registrations from year 2000 and later. For the genotypes, we only inlcude genotypes of AI bulls in the evaluations, to combat bias problems since dead calves are not genotyped. Other genotyped animals get a genomic breeding value based on calculated SNP solutions, similar to the existing weekly and monthly evaluations.

For Holstein and RDC, we include information from foreign bulls via Interbull. This information is only for traits 1 and 2 (still birth, early and calving ease early).

For compactness of tables, we will use abbreviations throughout. They are mentioned here:

- ss: single-step breeding value
- ebv: tradition pedigree-based breeding value
- cor: correlation
- rel: reliability
- m_*: mean value of *
- s_*: standard deviation of *

Holstein

Genetic trends

Here, we exhibit the genetic trends of our evaluations for each trait. We see that the levels of breeding values are generally in agreement across evaluations.

Table 1: Genetic trends (Single-step (ss) vs new EBV (newebv) vs official EBV (offebv)) and correlation between single-step and official EBV for nordic AI bulls with at least 30 offspring in the full dataset

BYR	trait	n	m_ss	m_newebv	m_offebv	s_ss	s_newebv	s_offebv	cor
2010	sb1	194	99.74	99.44	98.63	7.8	7.84	7.81	0.96
2011	sb1	154	99.85	99.12	98.4	7.03	7.11	7.06	0.96
2012	sb1	170	98.92	98.64	98.06	8.4	8.45	8.36	0.97
2013	sb1	151	101.64	101.48	101.11	7.09	7.2	7.13	0.96
2014	sb1	113	100.06	100.28	100.1	7.37	7.18	7.13	0.97
2015	sb1	82	101.87	101.68	101.65	7.44	7.57	7.5	0.98
2016	sb1	65	99.68	99.57	99.63	7.84	8.01	7.83	0.98
2017	sb1	65	100.0	100.17	100.42	7.8	8.17	8.14	0.98
2018	sb1	78	99.88	99.81	100.19	6.86	6.53	6.46	0.96
2019	sb1	56	100.05	100.21	100.84	6.37	6.3	6.21	0.96

BYR	trait	n	m_ssm	m_newebv	m_offebv	s_ss	s_newebv	s_offebv	cor
2020	sb1	53	99.96	100.34	101.03	5.8	6.13	5.94	0.97
2021	sb1	43	100.56	101.16	101.8	5.54	5.3	5.24	0.96
2022	sb1	41	98.0	98.05	98.69	5.23	5.3	5.22	0.94
2010	ce1	194	97.91	97.79	97.26	7.52	7.51	7.6	0.98
2011	ce1	154	97.94	97.77	97.38	6.96	7.13	7.2	0.98
2012	ce1	170	98.84	98.8	98.45	7.67	7.71	7.79	0.98
2013	ce1	151	101.07	101.18	100.88	6.53	6.74	6.8	0.98
2014	ce1	113	99.95	100.01	99.9	6.8	6.87	6.96	0.99
2015	ce1	82	101.44	101.41	101.44	4.59	4.77	4.83	0.98
2016	ce1	65	100.8	100.68	100.77	5.66	5.63	5.66	0.99
2017	ce1	65	100.72	100.91	100.99	5.38	5.55	5.64	0.98
2018	ce1	78	100.41	100.41	100.54	4.74	4.62	4.73	0.97
2019	ce1	56	101.52	101.27	101.41	4.58	4.58	4.56	0.97
2020	ce1	53	102.45	102.23	102.41	3.93	3.6	3.53	0.93
2021	ce1	43	99.84	100.09	100.28	4.47	4.17	4.16	0.95
2022	ce1	41	101.66	101.39	101.45	3.31	3.01	3.02	0.92
2010	cs1	194	102.26	101.92	101.88	8.4	8.36	8.39	0.98
2011	cs1	154	102.49	102.16	102.09	7.5	7.62	7.6	0.98
2012	cs1	170	101.18	100.98	100.88	8.28	8.28	8.3	0.98
2013	cs1	151	99.95	99.89	99.82	7.56	7.8	7.78	0.99
2014	cs1	113	99.68	99.62	99.5	8.16	8.25	8.25	0.99
2015	cs1	82	97.49	97.41	97.29	6.66	6.87	6.91	1.0
2016	cs1	65	98.51	98.42	98.33	7.14	7.25	7.26	0.99
2017	cs1	65	97.71	97.86	97.69	7.55	7.73	7.76	0.99
2018	cs1	78	98.91	99.13	99.01	6.46	6.57	6.61	0.99
2019	cs1	56	97.5	97.8	97.79	5.4	5.53	5.48	0.98
2020	cs1	53	96.42	96.7	96.67	5.44	5.15	5.17	0.96
2021	cs1	43	97.42	98.02	98.01	6.95	6.69	6.65	0.97
2022	cs1	41	96.29	97.1	97.07	5.83	5.72	5.77	0.99
2010	sb2	194	96.97	97.48	99.02	7.5	7.79	7.38	0.96
2011	sb2	154	97.67	97.81	99.2	7.12	7.32	6.92	0.96
2012	sb2	170	97.41	97.62	98.91	8.16	8.51	8.03	0.97
2013	sb2	151	98.64	98.75	99.92	6.85	7.09	6.65	0.96

BYR	trait	n	m_ssm	m_newebv	m_offebv	s_ss	s_newebv	s_offebv	cor
2014	sb2	113	99.65	99.88	100.76	7.12	7.04	6.71	0.98
2015	sb2	82	99.87	100.22	100.85	6.34	6.47	6.11	0.97
2016	sb2	65	99.49	99.57	100.15	6.41	6.55	6.38	0.98
2017	sb2	65	100.28	100.29	100.68	6.84	7.31	6.9	0.97
2018	sb2	78	100.41	100.14	100.55	5.77	5.85	5.46	0.97
2019	sb2	56	100.96	100.61	100.77	5.67	5.62	5.31	0.96
2020	sb2	53	101.6	101.32	101.41	5.97	6.35	6.01	0.95
2021	sb2	43	103.05	102.53	102.52	4.33	4.6	4.32	0.94
2022	sb2	41	101.76	101.49	101.32	5.47	5.24	4.94	0.97
2010	ce2	194	97.15	97.32	97.53	7.12	7.44	7.39	0.99
2011	ce2	154	97.09	96.95	97.05	5.6	5.83	5.85	0.99
2012	ce2	170	98.19	98.02	98.2	6.67	6.81	6.81	0.99
2013	ce2	151	99.15	98.97	99.13	5.73	6.01	6.0	0.99
2014	ce2	113	99.96	99.87	99.97	5.62	5.77	5.78	0.99
2015	ce2	82	101.1	101.06	101.09	3.99	4.21	4.17	0.99
2016	ce2	65	100.49	100.43	100.45	4.63	4.71	4.7	0.99
2017	ce2	65	100.32	100.35	100.35	4.66	4.76	4.78	1.0
2018	ce2	78	100.46	100.37	100.32	4.16	4.26	4.18	0.99
2019	ce2	56	101.82	101.98	101.82	3.93	3.98	4.06	0.99
2020	ce2	53	101.83	101.68	101.53	2.93	3.01	2.98	0.96
2021	ce2	43	100.49	100.37	100.19	4.14	4.25	4.23	0.99
2022	ce2	41	101.78	101.73	101.47	3.24	2.97	3.03	0.95
2010	cs2	194	103.46	102.88	102.65	7.89	7.9	7.92	0.98
2011	cs2	154	103.21	102.75	102.53	7.6	7.78	7.79	0.99
2012	cs2	170	102.16	101.87	101.71	7.97	7.78	7.84	0.99
2013	cs2	151	100.81	100.83	100.62	6.97	7.04	7.07	0.98
2014	cs2	113	100.62	100.57	100.49	7.37	7.51	7.54	1.0
2015	cs2	82	98.83	98.85	98.74	6.34	6.48	6.5	1.0
2016	cs2	65	99.31	99.31	99.3	7.04	7.08	7.09	1.0
2017	cs2	65	97.75	97.85	97.9	7.37	7.39	7.47	1.0
2018	cs2	78	98.54	98.81	98.89	7.19	7.31	7.29	1.0
2019	cs2	56	97.23	97.71	97.8	6.14	6.19	6.26	0.99
2020	cs2	53	95.85	96.36	96.42	5.87	5.63	5.73	0.98

BYR	trait	n	m_ssm_newebv	m_offebv	s_ss	s_newebv	s_offebv	cor
2021	cs2	43	96.53	97.26	97.33	6.58	6.66	6.65	0.98
2022	cs2	41	95.29	96.12	96.1	6.03	6.01	5.95	0.97

Table 2: Genetic trends (Single-step full dataset (f) vs single-step reduced dataset (r)) for nordic AI bulls with at least 30 offspring in the full dataset

BYR	trait	n	m_f	m_r	s_f	s_r	mean_diff	cor
2010	sb1	194	98.6	98.54	7.79	7.93	0.46	1.0
2011	sb1	154	98.7	98.74	7.02	7.02	0.4	1.0
2012	sb1	170	97.81	97.85	8.46	8.46	0.45	1.0
2013	sb1	151	100.5	100.56	7.08	7.16	0.49	0.99
2014	sb1	113	98.87	98.81	7.35	7.51	0.45	1.0
2015	sb1	82	100.7	100.82	7.52	7.54	0.41	1.0
2016	sb1	65	98.57	98.74	7.97	8.16	0.66	0.99
2017	sb1	65	98.85	99.11	7.76	8.04	0.78	0.99
2018	sb1	78	98.69	99.12	6.81	7.1	3.63	0.75
2019	sb1	56	98.98	99.61	6.38	6.25	3.77	0.71
2020	sb1	53	98.83	99.34	5.8	6.64	4.55	0.62
2021	sb1	43	99.51	99.7	5.53	7.12	4.0	0.67
2022	sb1	41	96.83	99.8	5.34	6.13	4.49	0.59
2023	sb1	7	99.14	101.57	7.99	3.99	3.86	0.7
2010	ce1	194	97.43	97.46	7.69	7.75	0.3	1.0
2011	ce1	154	97.49	97.49	7.02	7.13	0.29	1.0
2012	ce1	170	98.34	98.39	7.73	7.79	0.32	1.0
2013	ce1	151	100.7	100.85	6.61	6.67	0.32	1.0
2014	ce1	113	99.57	99.57	6.87	6.91	0.27	1.0
2015	ce1	82	101.16	101.21	4.73	4.73	0.29	0.99
2016	ce1	65	100.45	100.66	5.74	5.72	0.43	0.99
2017	ce1	65	100.49	100.71	5.42	5.76	0.71	0.99
2018	ce1	78	100.1	100.71	4.8	6.4	3.78	0.66
2019	ce1	56	101.11	101.98	4.66	5.65	3.62	0.66
2020	ce1	53	102.08	102.75	4.08	7.06	3.85	0.75
2021	ce1	43	99.6	101.23	4.62	6.46	3.86	0.69
2022	ce1	41	101.32	103.37	3.2	5.94	3.9	0.63
2023	ce1	7	102.86	103.43	4.14	5.97	3.71	0.68

BYR	trait	n	m_f	m_r	s_f	s_r	mean_diff	cor
2010	cs1	194	101.93	101.94	8.49	8.47	0.47	1.0
2011	cs1	154	102.11	102.14	7.57	7.66	0.47	0.99
2012	cs1	170	100.88	100.76	8.27	8.27	0.51	1.0
2013	cs1	151	99.57	99.49	7.58	7.66	0.54	0.99
2014	cs1	113	99.41	99.38	8.13	8.2	0.45	1.0
2015	cs1	82	97.16	97.05	6.79	6.82	0.38	1.0
2016	cs1	65	98.11	97.94	7.1	7.15	0.45	0.99
2017	cs1	65	97.34	96.69	7.58	7.75	0.83	0.99
2018	cs1	78	98.5	98.91	6.51	6.41	4.18	0.63
2019	cs1	56	97.16	97.09	5.34	5.06	3.61	0.61
2020	cs1	53	96.0	96.58	5.42	7.42	4.77	0.62
2021	cs1	43	97.16	97.49	6.93	6.0	3.72	0.74
2022	cs1	41	95.93	96.24	5.88	5.15	3.78	0.57
2023	cs1	7	97.0	96.86	4.47	5.15	2.43	0.84
2010	sb2	194	98.18	98.22	7.38	7.43	0.68	0.99
2011	sb2	154	98.84	98.81	7.07	7.12	0.67	0.99
2012	sb2	170	98.6	98.65	8.04	8.12	0.57	0.99
2013	sb2	151	99.87	99.9	6.75	6.64	0.66	0.99
2014	sb2	113	100.8	100.52	6.99	7.11	0.72	0.99
2015	sb2	82	101.1	100.66	6.27	6.45	0.8	0.99
2016	sb2	65	100.65	100.22	6.38	6.35	0.95	0.98
2017	sb2	65	101.37	100.57	6.86	7.06	1.26	0.98
2018	sb2	78	101.55	101.1	5.71	5.48	4.19	0.57
2019	sb2	56	102.09	101.79	5.61	5.31	4.59	0.41
2020	sb2	53	102.74	102.02	5.94	6.2	5.66	0.39
2021	sb2	43	104.16	103.47	4.22	6.3	4.56	0.4
2022	sb2	41	102.88	103.56	5.44	5.87	4.24	0.51
2023	sb2	7	104.43	103.29	3.51	5.09	2.86	0.69
2010	ce2	194	97.38	97.31	7.14	7.23	0.29	1.0
2011	ce2	154	97.25	97.3	5.65	5.68	0.28	1.0
2012	ce2	170	98.42	98.51	6.71	6.77	0.25	1.0
2013	ce2	151	99.29	99.48	5.76	5.8	0.34	0.99
2014	ce2	113	100.13	100.26	5.64	5.78	0.37	0.99

BYR	trait	n	m_f	m_r	s_f	s_r	mean_diff	cor
2015	ce2	82	101.34	101.35	4.05	4.18	0.28	0.99
2016	ce2	65	100.71	100.63	4.67	4.68	0.42	0.99
2017	ce2	65	100.58	100.14	4.71	4.72	0.69	0.98
2018	ce2	78	100.64	101.01	4.16	4.5	3.01	0.62
2019	ce2	56	102.12	101.86	3.91	5.37	3.88	0.48
2020	ce2	53	101.98	102.68	2.93	5.72	4.25	0.42
2021	ce2	43	100.6	102.3	4.13	5.51	3.98	0.52
2022	ce2	41	101.95	103.17	3.15	4.92	3.61	0.48
2023	ce2	7	102.57	102.86	2.99	5.49	3.14	0.67
2010	cs2	194	102.84	102.81	7.87	7.85	0.39	1.0
2011	cs2	154	102.6	102.58	7.7	7.73	0.39	1.0
2012	cs2	170	101.45	101.36	7.98	7.93	0.3	1.0
2013	cs2	151	100.21	100.0	7.05	7.04	0.42	0.99
2014	cs2	113	99.93	100.04	7.41	7.45	0.27	1.0
2015	cs2	82	98.06	98.01	6.41	6.51	0.22	1.0
2016	cs2	65	98.55	98.57	6.99	7.19	0.48	0.99
2017	cs2	65	97.06	96.62	7.44	7.61	0.57	1.0
2018	cs2	78	97.88	98.95	7.29	6.2	4.04	0.73
2019	cs2	56	96.64	97.02	6.28	6.03	3.7	0.73
2020	cs2	53	95.04	96.55	5.86	6.31	3.89	0.7
2021	cs2	43	95.74	96.91	6.77	6.43	4.28	0.72
2022	cs2	41	94.68	95.93	6.06	5.65	4.41	0.56
2023	cs2	7	97.29	96.86	5.41	6.2	2.14	0.9

Table 3: Genetic trends (Single-step full dataset (f) vs single-step reduced dataset (r)) for nordic cows with genotype and phenotype

BYR	trait	n	m_f	m_r	s_f	s_r	mean_diff	cor
2010	sb1	1791	96.81	96.7	6.75	6.82	0.85	0.99
2011	sb1	3440	97.36	97.21	6.27	6.34	0.88	0.98
2012	sb1	5402	97.07	96.98	6.19	6.24	0.87	0.98
2013	sb1	9155	97.36	97.29	5.96	6.02	0.85	0.98
2014	sb1	10807	97.34	97.32	6.0	6.08	0.87	0.98
2015	sb1	13642	98.08	98.11	6.15	6.22	0.87	0.98
2016	sb1	21034	98.88	98.92	6.42	6.5	0.87	0.98

BYR	trait	n	m_f	m_r	s_f	s_r	mean_diff	cor
2017	sb1	31359	99.06	99.14	6.56	6.65	0.91	0.98
2018	sb1	43750	98.61	98.76	6.12	6.22	0.91	0.98
2019	sb1	49277	98.48	98.66	6.44	6.53	0.96	0.98
2020	sb1	59160	98.99	99.32	5.9	6.04	1.59	0.93
2021	sb1	63173	98.84	99.36	5.74	6.02	1.95	0.91
2022	sb1	71529	98.53	99.02	5.71	5.93	2.08	0.9
2023	sb1	78435	98.6	99.07	5.5	5.87	2.07	0.89
2024	sb1	83116	98.62	99.05	5.33	5.91	2.32	0.86
2025	sb1	25843	97.63	98.6	5.48	5.63	2.49	0.84
2010	ce1	1791	95.04	94.9	6.58	6.76	0.79	0.99
2011	ce1	3440	95.37	95.24	6.21	6.35	0.77	0.99
2012	ce1	5402	96.07	95.96	5.84	5.99	0.76	0.99
2013	ce1	9155	96.82	96.75	5.71	5.84	0.75	0.98
2014	ce1	10807	97.19	97.17	5.97	6.13	0.75	0.99
2015	ce1	13642	97.95	97.97	6.0	6.13	0.75	0.99
2016	ce1	21034	98.69	98.71	5.98	6.11	0.76	0.99
2017	ce1	31359	98.97	98.97	5.96	6.11	0.77	0.99
2018	ce1	43750	98.95	99.04	5.78	5.93	0.78	0.98
2019	ce1	49277	99.23	99.41	5.78	5.95	0.8	0.98
2020	ce1	59160	99.63	99.95	5.55	6.0	1.31	0.95
2021	ce1	63173	100.03	100.8	5.41	6.18	2.04	0.91
2022	ce1	71529	100.2	100.89	5.32	6.05	1.96	0.92
2023	ce1	78435	100.27	100.89	5.21	6.03	2.01	0.91
2024	ce1	83116	100.35	100.97	5.11	5.95	2.04	0.9
2025	ce1	25843	100.18	100.76	5.12	5.97	1.99	0.9
2010	cs1	1791	105.31	105.35	6.69	6.69	1.04	0.98
2011	cs1	3440	104.94	105.01	6.38	6.45	1.04	0.98
2012	cs1	5402	104.25	104.28	6.27	6.31	1.04	0.98
2013	cs1	9155	103.51	103.54	6.15	6.14	1.03	0.98
2014	cs1	10807	102.78	102.79	6.5	6.52	1.03	0.98
2015	cs1	13642	101.92	101.9	6.46	6.46	1.04	0.98
2016	cs1	21034	101.28	101.27	6.3	6.32	1.04	0.98
2017	cs1	31359	100.87	100.86	6.21	6.21	1.05	0.98

BYR	trait	n	m_f	m_r	s_f	s_r	mean_diff	cor
2018	cs1	43750	100.73	100.7	6.21	6.22	1.07	0.97
2019	cs1	49277	100.27	100.1	6.13	6.17	1.11	0.97
2020	cs1	59160	99.45	99.11	5.95	5.99	1.68	0.93
2021	cs1	63173	98.93	98.91	5.71	5.84	2.06	0.9
2022	cs1	71529	98.45	98.56	5.65	5.84	2.15	0.89
2023	cs1	78435	98.36	99.0	5.51	5.88	2.54	0.85
2024	cs1	83116	97.99	98.58	5.65	5.62	2.29	0.87
2025	cs1	25843	98.29	98.98	5.77	5.64	2.48	0.85
2010	sb2	1791	95.82	95.76	5.77	5.87	1.08	0.97
2011	sb2	3440	96.85	96.82	5.54	5.66	1.08	0.97
2012	sb2	5402	97.1	97.1	5.45	5.54	1.06	0.97
2013	sb2	9155	97.51	97.49	5.43	5.49	1.06	0.97
2014	sb2	10807	98.19	98.22	5.37	5.48	1.05	0.97
2015	sb2	13642	98.48	98.53	5.42	5.49	1.08	0.97
2016	sb2	21034	99.54	99.52	5.36	5.43	1.07	0.97
2017	sb2	31359	99.99	99.86	5.6	5.68	1.11	0.97
2018	sb2	43750	100.29	100.15	5.41	5.49	1.13	0.96
2019	sb2	49277	100.28	99.97	5.33	5.37	1.19	0.96
2020	sb2	59160	100.87	100.39	5.07	5.26	1.88	0.88
2021	sb2	63173	100.94	101.17	5.09	5.45	2.49	0.82
2022	sb2	71529	101.32	101.29	5.04	5.47	2.59	0.81
2023	sb2	78435	101.79	101.71	4.99	5.26	2.64	0.79
2024	sb2	83116	102.15	101.84	4.75	5.35	2.85	0.73
2025	sb2	25843	101.26	101.83	4.75	5.08	2.63	0.78
2010	ce2	1791	95.19	95.03	5.19	5.4	0.91	0.97
2011	ce2	3440	95.67	95.42	4.97	5.15	0.94	0.97
2012	ce2	5402	96.24	96.09	4.84	4.99	0.9	0.97
2013	ce2	9155	96.99	96.88	4.66	4.79	0.89	0.97
2014	ce2	10807	97.14	97.1	4.69	4.86	0.9	0.97
2015	ce2	13642	97.8	97.82	4.68	4.82	0.91	0.97
2016	ce2	21034	98.54	98.57	4.6	4.72	0.9	0.97
2017	ce2	31359	99.27	99.28	4.58	4.71	0.92	0.97
2018	ce2	43750	99.46	99.5	4.53	4.68	0.93	0.96

BYR	trait	n	m_f	m_r	s_f	s_r	mean_diff	cor
2019	ce2	49277	99.54	99.51	4.47	4.62	0.95	0.96
2020	ce2	59160	100.17	100.19	4.38	4.67	1.38	0.92
2021	ce2	63173	100.55	100.99	4.24	4.95	1.99	0.85
2022	ce2	71529	100.7	101.24	4.1	4.9	2.01	0.85
2023	ce2	78435	100.77	101.56	4.04	4.87	2.15	0.84
2024	ce2	83116	101.13	101.48	3.99	4.88	2.29	0.81
2025	ce2	25843	101.02	101.34	3.99	4.63	2.01	0.84
2010	cs2	1791	106.41	106.5	6.4	6.46	0.98	0.98
2011	cs2	3440	105.85	105.93	6.24	6.28	1.01	0.98
2012	cs2	5402	104.94	105.02	6.16	6.16	1.0	0.98
2013	cs2	9155	104.09	104.11	5.95	5.93	1.01	0.97
2014	cs2	10807	103.42	103.45	6.35	6.38	1.01	0.98
2015	cs2	13642	102.28	102.26	6.3	6.3	1.03	0.98
2016	cs2	21034	101.75	101.72	6.1	6.1	1.01	0.98
2017	cs2	31359	101.14	101.16	6.12	6.1	1.02	0.98
2018	cs2	43750	101.16	101.15	6.03	6.05	1.04	0.97
2019	cs2	49277	100.35	100.25	6.13	6.17	1.06	0.97
2020	cs2	59160	99.43	99.46	5.98	5.94	1.51	0.94
2021	cs2	63173	98.41	99.07	5.7	5.82	2.05	0.9
2022	cs2	71529	97.78	98.64	5.69	5.7	2.17	0.89
2023	cs2	78435	97.52	98.83	5.45	5.63	2.47	0.87
2024	cs2	83116	96.97	98.28	5.57	5.47	2.39	0.88
2025	cs2	25843	97.26	98.63	5.51	5.29	2.54	0.85

Test of Foreign information

As part of the Interbull collaboration, we recieve breeding values from foreign (non-nordic) bulls, along with a reliability. These has to be converted to a pseudo-phenotype to be included in the evaluation. Here, we test that the calculated breeding values for these bulls are similar to the original ones from Interbull in mean and standard deviation.

Table 4: Means and standard deviations for foreign bulls in new single-step (ss), new EBV (ebv) and original interbull breeding value (bv), as well as correlation between single-step breeding value and Interbull breeding value. Still birth first lactation.

BYR	n	m_ss	m_ebv	m_bv	s_ss	s_ebv	s_bv	cor_ss	cor_ebv
2009	400	93.39	92.87	92.06	9.74	9.73	8.91	0.88	0.92
2010	524	94.59	93.98	93.55	7.97	7.56	6.87	0.85	0.89

BYR	n	m_ss	m_ebv	m_bv	s_ss	s_ebv	s_bv	cor_ss	cor_ebv
2011	484	95.3	94.84	94.63	7.95	7.6	6.93	0.85	0.88
2012	529	96.28	95.86	96.05	8.01	7.77	7.57	0.83	0.87
2013	418	96.34	95.91	96.25	8.41	7.95	8.17	0.84	0.86
2014	364	95.64	95.15	96.5	7.38	7.08	7.09	0.86	0.86
2015	280	96.43	96.19	97.58	7.16	6.85	6.84	0.82	0.87
2016	269	94.65	93.78	95.93	7.03	6.7	6.61	0.83	0.86
2017	255	96.17	95.61	98.83	6.92	6.31	6.68	0.79	0.86
2018	208	95.14	94.89	98.14	7.24	6.27	6.39	0.82	0.89
2019	226	96.79	95.69	99.7	6.89	6.35	6.98	0.79	0.88
2020	147	96.52	95.9	99.8	6.39	5.67	5.87	0.83	0.87
2021	178	97.42	96.2	101.03	5.79	5.14	5.15	0.73	0.81
2022	73	95.96	95.07	99.17	6.4	5.73	5.13	0.79	0.88

Table 5: Means and standard deviations for foreign bulls in new single-step (ss), new EBV (ebv) and original interbull breeding value (bv), as well as correlation between single-step breeding value and Interbull breeding value. Calving ease first lactation.

BYR	n	m_ss	m_ebv	m_bv	s_ss	s_ebv	s_bv	cor_ss	cor_ebv
2009	833	91.53	91.29	91.39	10.41	10.5	9.08	0.93	0.97
2010	1041	94.25	94.17	93.92	8.45	8.19	7.26	0.91	0.95
2011	925	94.1	94.11	94.06	8.26	8.05	7.24	0.9	0.94
2012	907	95.27	95.26	95.17	8.22	7.9	7.16	0.91	0.95
2013	755	95.3	95.2	95.62	7.78	7.48	6.88	0.9	0.94
2014	589	95.51	95.46	96.23	7.72	7.24	6.77	0.91	0.95
2015	460	94.75	94.85	95.63	7.56	7.24	6.64	0.89	0.95
2016	411	94.96	95.03	96.39	7.28	7.0	6.26	0.88	0.94
2017	394	95.83	95.66	97.59	7.18	6.61	6.22	0.86	0.93
2018	328	96.14	96.29	98.19	6.83	5.96	5.5	0.87	0.93
2019	341	97.1	97.0	99.29	6.86	6.22	5.8	0.88	0.95
2020	202	98.06	97.5	99.65	6.81	6.03	5.39	0.88	0.94
2021	221	98.49	97.81	100.41	5.51	4.64	4.35	0.78	0.89
2022	129	98.68	98.18	100.14	5.77	4.96	4.62	0.8	0.92

Correlations

Here, we give correlation tables and tables of differences between the relevant evaluations. We test that we didn't change the model by comparing our new model without genomic

information to the breeding values of the traditional pedigree-based model and expect very high correlations for tested animals. We test the change by incorporating genomic information, compared to a non-genomic evaluation, and expect to see some changes even in tested animals, but not too large.

Table 6: Correlations between current EBV and new EBV for Nordic AI bulls with > 30 offspring

BYR	n	cor1	cor2	cor3	cor4	cor5	cor6
2009	224	0.998	0.999	0.999	0.998	0.999	0.999
2010	194	0.997	0.999	0.999	0.997	0.999	0.999
2011	154	0.998	0.999	0.999	0.998	0.998	0.999
2012	170	0.999	0.999	0.999	0.999	0.999	0.999
2013	151	0.998	0.998	0.999	0.998	0.999	0.999
2014	113	0.998	0.999	0.999	0.998	0.999	0.999
2015	82	0.998	0.998	0.999	0.998	0.997	0.999
2016	65	0.999	0.998	0.999	0.998	0.998	0.999
2017	65	0.999	0.999	0.999	0.999	0.998	0.999
2018	78	0.998	0.997	0.999	0.997	0.997	0.999
2019	56	0.998	0.998	0.998	0.998	0.997	0.999
2020	53	0.997	0.996	0.999	0.999	0.994	0.998
2021	43	0.997	0.997	0.999	0.998	0.998	0.999
2022	41	0.998	0.995	0.999	0.998	0.994	0.999

Table 7: Table of differences between current EBV and new EBV for Nordic AI bulls with > 30 offspring born after 2015

dif	dif1	dif2	dif3	dif4	dif5	dif6
−1.0	7	6	28	30	44	4
0.0	222	343	378	257	357	385
1.0	175	59	2	111	7	19
2.0	2	0	0	10	0	0
3.0	2	0	0	0	0	0

Table 8: Correlations between current EBV and new Single-step for AI bulls with > 30 offspring

BYR	n	cor1	cor2	cor3	cor4	cor5	cor6
2009	224	0.978	0.985	0.983	0.975	0.994	0.985
2010	194	0.956	0.979	0.978	0.961	0.991	0.98
2011	154	0.955	0.983	0.984	0.964	0.991	0.986

BYR	n	cor1	cor2	cor3	cor4	cor5	cor6
2012	170	0.97	0.984	0.984	0.974	0.991	0.986
2013	151	0.962	0.977	0.986	0.962	0.988	0.983
2014	113	0.973	0.986	0.992	0.976	0.99	0.996
2015	82	0.98	0.976	0.996	0.968	0.988	0.998
2016	65	0.984	0.987	0.993	0.981	0.992	0.998
2017	65	0.98	0.982	0.993	0.975	0.995	0.998
2018	78	0.964	0.967	0.989	0.965	0.987	0.998
2019	56	0.961	0.967	0.985	0.963	0.986	0.995
2020	53	0.97	0.927	0.96	0.952	0.956	0.983
2021	43	0.962	0.95	0.966	0.944	0.988	0.982
2022	41	0.942	0.921	0.989	0.974	0.95	0.975

Table 9: Table of differences between current EBV and new Single-step for AI bulls with > 30 offspring born after 2015

dif	dif1	dif2	dif3	dif4	dif5	dif6
−8.0	0	0	1	0	0	0
−7.0	1	0	0	0	0	0
−6.0	0	0	0	0	0	0
−5.0	1	1	0	4	0	0
−4.0	6	6	1	4	0	1
−3.0	12	8	0	15	2	1
−2.0	19	10	16	33	14	3
−1.0	38	58	53	73	84	19
0.0	99	217	214	141	249	234
1.0	147	75	88	72	49	122
2.0	48	19	20	46	7	17
3.0	19	10	9	11	3	5
4.0	11	3	3	6	0	4
5.0	5	0	2	3	0	2
6.0	1	1	0	0	0	0
7.0	0	0	0	0	0	0
8.0	0	0	1	0	0	0
9.0	1	0	0	0	0	0

Table 10: Correlations between current two-step and new Single-step (combined birth index) for genotyped AI bulls born after 2009 with > 30 offspring

BYR	n	cor
2009	223	0.95
2010	193	0.946
2011	154	0.942
2012	170	0.958
2013	151	0.943
2014	113	0.962
2015	82	0.967
2016	65	0.973
2017	65	0.981
2018	78	0.942
2019	56	0.943
2020	53	0.938
2021	43	0.95
2022	41	0.821

Table 11: Table of differences between current two-step and new Single-step (combined birth index) for genotyped AI bulls with > 30 offspring born after 2015

dif	dif13
−7.0	1
−6.0	0
−5.0	1
−4.0	4
−3.0	8
−2.0	23
−1.0	42
0.0	92
1.0	112
2.0	57
3.0	32
4.0	18
5.0	10
6.0	5

dif	dif13
7.0	0
8.0	1
9.0	0
10.0	2

Table 12: Table of differences between current two-step and new Single-step for genotyped nordic bulls with no offspring born after 2020

BYR	n	cor
2020	3094	0.736
2021	3054	0.734
2022	3118	0.742
2023	3014	0.709
2024	3001	0.712
2025	1276	0.661

Table 13: Correlations between current two-step and new Single-step for genotyped nordic bulls born after 2020 with no offspring

dif	dif13
−13.0	1
−12.0	7
−11.0	10
−10.0	28
−9.0	67
−8.0	106
−7.0	198
−6.0	386
−5.0	561
−4.0	816
−3.0	1043
−2.0	1288
−1.0	1470
0.0	1593
1.0	1459
2.0	1306
3.0	1090

dif	dif13
4.0	831
5.0	569
6.0	397
7.0	248
8.0	116
9.0	64
10.0	24
11.0	13
12.0	7
13.0	6
14.0	2
15.0	1

Legarra-Reverter test

The Legarra-Reverter test is a test for bias in evaluations. We perform two calculations of breeding values, one with all information available and one where offspring of sires born after 2018 has their records removed. Then we perform a linear regression on genotyped, nordic bulls, who has no data in the reduced dataset and with more than 30 offspring in the full dataset. We also require that their sires are not in the focal group, so we remove bulls whose father meets the same criteria.

The slope of the regression indicates the bias, with a slope of one meaning no bias, a slope less than one indicating that the estimated values of unproven animals are too extreme, and a slope higher than one indicating that the estimated breeding values of unproven animals are too conservative.

As can be seen, we have some issues with the Legarra-Reverter test. We're looking into it.

Table 14: Legarra-Reverter scores
Singlestep:

trait	b1	rsquare	n
nysb1	0.721	0.551	141
nyce1	0.5	0.429	140
nycs1	0.619	0.373	126
nysb2	0.551	0.264	141
nyce2	0.439	0.283	141
nycs2	0.845	0.56	134

EBV:

trait	b1	rsquare	n
nysb1	0.704	0.349	141
nyce1	0.487	0.17	140
nycs1	0.467	0.148	126
nysb2	0.486	0.116	141
nyce2	0.453	0.128	141
nycs2	0.776	0.299	134

Interbull test

An Interbull GEBV test was performed with a failing grade.

```
735 brd pop trt evaldate m ntest    mean_y     std_y dv    mean_x     std_x        b0     se_b0      b1   se_b1 ncand
i_est  Exp_b1   R2 fb year  tests  pass
735 HOL DFS sb1 20250904 1   108   97.7928    7.5801 GM   98.5967    7.0063   19.4372    6.9407  0.7950  0.0663   108
0.0000  1.0000 54.7  N 2015   NNNY  FAIL
735 HOL DFS sb1 20250904 2   108   97.7928    7.5801 GM   98.4772    5.8132   10.6404    9.0375  0.8851  0.0917   108
0.0000  1.0000 46.8  N 2015   ----  ----
735 HOL DFS ce1 20250904 1   100   99.7673    5.2805 GM  100.5532    5.6430   41.5086    7.4641  0.5799  0.1015   100
0.0000  1.0000 38.4  N 2015   NNNY  FAIL
735 HOL DFS ce1 20250904 2   100   99.7673    5.2805 GM  100.1953    4.0056   36.4959   11.5963  0.6320  0.1157   100
0.0000  1.0000 23.4  N 2015   ----  ----
735 HOL DFS cs1 20250904 1    87   98.3351    6.7975 GM   98.8229    5.4112   15.4626   10.0323  0.8382  0.1029    87
0.0000  1.0000 44.6  N 2015   YYNY  PASS
735 HOL DFS cs1 20250904 2    87   98.3351    6.7975 GM   99.6585    5.0740   31.8668   12.4786  0.6665  0.1250    87
0.0000  1.0000 25.1  N 2015   ----  ----
735 HOL DFS sb2 20250904 1   101  100.8622    7.1465 GM  100.8595    5.5525   15.1400    9.6745  0.8499  0.0886   101
0.0000  1.0000 44.3  N 2015   YYNY  PASS
735 HOL DFS sb2 20250904 2   101  100.8622    7.1465 GM   99.8847    4.7922   17.9168   12.2459  0.8304  0.1225   101
0.0000  1.0000 31.7  N 2015   ----  ----
735 HOL DFS ce2 20250904 1   105  100.4787    4.9019 GM  100.8092    4.7744   52.9046    9.0210  0.4726  0.1162   105
0.0000  1.0000 21.3  N 2015   NNN-  FAIL
735 HOL DFS ce2 20250904 2   105  100.4787    4.9019 GM  100.2720    3.7591   42.9447   11.3799  0.5743  0.1134   105
0.0000  1.0000 19.9  N 2015   ----  ----
735 HOL DFS cs2 20250904 1    89   97.9157    7.2312 GM   98.3781    5.5505   10.6624    9.9122  0.8858  0.0794    89
0.0000  1.0000 47.1  N 2015   YYNY  PASS
735 HOL DFS cs2 20250904 2    89   97.9157    7.2312 GM   99.5491    4.7132   14.7380   13.5829  0.8342  0.1362    89
0.0000  1.0000 30.1  N 2015   ----  ----
```

The set of bulls chosen by the Interbull test program is different from the focal group selected for the Legarra-Reverter test. Hence, we get different slope coefficients.

Mendelian sampling

The mendelian sampling of an animals is its deviation of its breeding values from the expected breeding value, which is the average of its parents breeding values. Some mendelian samling is expected on the individual level (this is what enables breeding), but across all animals we expect it to be close to zero. Otherwise, this indicates a bias in the set of animals in the evaluation, which violates the unbiasedness of the BLUP model. We conclude that the mendelian sampling is generally close to 0.

Table 15: Average mendelian sampling by birth year. Animals are only included if they are genotyped, their sire has > 30 offspring and their dam is genotyped.

BYR	m1	m2	m3	m4	m5	m6
2010	−0.015	−0.644	0.652	−0.238	−0.054	0.22
2011	−0.172	−0.391	0.463	−0.416	−0.148	−0.077
2012	−0.167	−0.135	0.091	−0.269	−0.097	−0.133
2013	0.144	0.23	−0.099	0.026	0.093	−0.196
2014	−0.077	0.022	−0.096	−0.035	−0.054	−0.074
2015	0.084	0.129	−0.115	0.046	0.017	−0.102
2016	−0.008	0.043	−0.06	0.002	0.039	−0.043
2017	−0.01	0.055	−0.082	−0.035	0.071	−0.085
2018	0.057	0.09	−0.099	0.065	0.104	−0.127
2019	0.167	0.211	−0.212	0.177	0.188	−0.267
2020	0.038	0.06	−0.062	0.052	0.078	−0.127
2021	−0.065	−0.047	0.051	−0.038	−0.055	0.034
2022	−0.047	−0.003	−0.001	−0.006	−0.012	0.018
2023	−0.017	−0.006	0.036	0.032	−0.008	0.029
2024	0.018	−0.007	−0.011	0.074	0.04	−0.049

Table 16: Average mendelian sampling by birth year. Animals are only included if they are not genotyped, their sire has > 30 offspring and their dam isn't genotyped.

BYR	m1	m2	m3	m4	m5	m6
2001	0.023	−0.017	−0.002	0.002	0.008	−0.022
2002	0.008	−0.016	−0.004	−0.002	0.002	0.022
2003	−0.004	−0.043	−0.009	0.005	0.007	0.021
2004	0.013	−0.018	−0.001	0.008	0.031	0.013
2005	−0.005	0.013	−0.017	0.009	0.032	0.001
2006	0.001	−0.005	−0.01	0.007	0.018	0.007
2007	−0.005	−0.027	−0.009	0.004	−0.0	0.017
2008	−0.003	−0.024	0.019	−0.025	0.018	0.03

BYR	m1	m2	m3	m4	m5	m6
2009	−0.002	−0.01	0.02	−0.038	0.044	0.038
2010	0.003	−0.001	−0.003	−0.028	0.037	0.001
2011	0.004	0.004	−0.021	−0.026	0.031	0.011
2012	−0.005	−0.008	−0.016	−0.019	0.023	0.008
2013	−0.008	0.017	−0.008	−0.018	0.013	−0.009
2014	−0.009	0.018	−0.008	−0.011	−0.017	−0.022
2015	−0.014	0.015	−0.001	−0.016	−0.028	−0.001
2016	0.009	−0.005	−0.017	−0.008	0.004	0.014
2017	−0.003	0.003	−0.012	−0.033	0.006	0.026
2018	−0.004	−0.011	0.005	−0.032	0.011	0.012
2019	0.006	0.005	0.026	−0.008	0.006	0.001
2020	−0.007	−0.009	0.029	−0.007	0.003	0.007
2021	−0.01	−0.008	0.014	−0.003	−0.027	0.021
2022	−0.02	−0.004	−0.006	0.003	−0.007	0.02
2023	−0.033	−0.021	0.019	0.003	−0.011	0.035
2024	−0.011	−0.034	0.025	0.014	0.012	0.017

Reliabilities

Table 17: Comparison of reliabilities between single-step (ss), new EBV (ebv) and current official evaluation (cur) for nordic AI bulls with > 30 offspring and correlation between single-step and current evaluation.

BYR	trait	n	rel_ss	rel_ebv	rel_cur	s_rel_ss	s_rel_ebv	s_rel_cur	cor
2010	sb1	194	86.15	76.08	77.77	5.38	9.3	8.57	0.95
2011	sb1	154	87.45	78.65	79.91	4.27	7.47	7.12	0.94
2012	sb1	170	88.38	80.08	81.6	5.54	9.89	9.09	0.97
2013	sb1	151	88.36	80.2	81.62	5.7	10.16	9.59	0.97
2014	sb1	113	90.61	84.06	85.52	6.54	11.8	10.72	0.99
2015	sb1	82	92.71	88.13	89.32	5.48	9.72	8.83	0.99
2016	sb1	65	92.08	87.23	88.31	5.36	9.3	8.52	0.99
2017	sb1	65	92.37	87.86	89.03	5.63	9.82	9.05	0.99
2018	sb1	78	90.24	84.24	86.0	6.43	11.53	10.25	0.99
2019	sb1	56	90.02	84.23	86.95	6.43	11.43	9.61	0.98
2020	sb1	53	86.68	78.69	84.92	8.98	16.19	12.23	0.96
2021	sb1	43	81.5	61.53	83.09	9.05	13.64	14.65	0.93

BYR	trait	n	rel_ss	rel_ebv	rel_cur	s_rel_ss	s_rel_ebv	s_rel_cur	cor
2022	sb1	41	81.36	56.88	85.38	8.3	7.66	12.8	0.93
2023	sb1	7	75.41	49.76	72.91	7.88	9.37	16.19	0.99
2010	ce1	194	85.6	76.08	85.86	5.59	9.3	6.16	0.93
2011	ce1	154	86.94	78.65	87.8	4.45	7.47	4.94	0.9
2012	ce1	170	87.91	80.08	88.62	5.77	9.89	6.53	0.95
2013	ce1	151	87.89	80.2	88.68	5.94	10.16	6.76	0.94
2014	ce1	113	90.24	84.06	91.29	6.8	11.8	7.66	0.97
2015	ce1	82	92.42	88.13	94.13	5.7	9.72	5.59	0.97
2016	ce1	65	91.76	87.23	93.67	5.57	9.3	5.08	0.98
2017	ce1	65	92.06	87.86	93.95	5.86	9.82	5.66	0.97
2018	ce1	78	89.84	84.24	91.8	6.68	11.53	6.93	0.97
2019	ce1	56	89.6	84.23	92.64	6.68	11.43	6.36	0.95
2020	ce1	53	86.11	78.69	90.93	9.34	16.19	8.77	0.94
2021	ce1	43	80.83	61.53	88.91	9.46	13.64	11.51	0.89
2022	ce1	41	80.76	56.88	91.2	8.71	7.66	9.72	0.88
2023	ce1	7	74.53	49.76	80.34	8.3	9.37	14.02	0.99
2010	cs1	194	85.18	76.08	−99.0	5.75	9.3	0.0	NaN
2011	cs1	154	86.56	78.65	−99.0	4.58	7.47	0.0	NaN
2012	cs1	170	87.56	80.08	−99.0	5.94	9.89	0.0	NaN
2013	cs1	151	87.53	80.2	−99.0	6.12	10.16	0.0	NaN
2014	cs1	113	89.95	84.06	−99.0	7.0	11.8	0.0	NaN
2015	cs1	82	92.19	88.13	−99.0	5.87	9.72	0.0	NaN
2016	cs1	65	91.51	87.23	−99.0	5.74	9.3	0.0	NaN
2017	cs1	65	91.82	87.86	−99.0	6.03	9.82	0.0	NaN
2018	cs1	78	89.53	84.24	−99.0	6.88	11.53	0.0	NaN
2019	cs1	56	89.28	84.23	−99.0	6.88	11.43	0.0	NaN
2020	cs1	53	85.68	78.69	−99.0	9.62	16.19	0.0	NaN
2021	cs1	43	80.32	61.53	−99.0	9.79	13.64	0.0	NaN
2022	cs1	41	80.3	56.88	−99.0	9.04	7.66	0.0	NaN
2023	cs1	7	73.85	49.76	−99.0	8.63	9.37	0.0	NaN
2010	sb2	194	86.44	76.08	72.99	5.23	9.3	9.22	0.97
2011	sb2	154	87.72	78.65	75.24	4.15	7.47	7.34	0.98
2012	sb2	170	88.62	80.08	76.79	5.4	9.89	9.74	0.98

BYR	trait	n	rel_ss	rel_ebv	rel_cur	s_rel_ss	s_rel_ebv	s_rel_cur	cor
2013	sb2	151	88.6	80.2	76.64	5.58	10.16	9.78	0.97
2014	sb2	113	90.81	84.06	80.6	6.41	11.8	11.44	0.98
2015	sb2	82	92.83	88.13	84.57	5.33	9.72	9.87	0.99
2016	sb2	65	92.25	87.23	83.69	5.23	9.3	9.79	0.99
2017	sb2	65	92.51	87.86	84.36	5.48	9.82	9.9	0.97
2018	sb2	78	90.44	84.24	81.48	6.28	11.53	10.97	0.98
2019	sb2	56	90.21	84.23	81.15	6.25	11.43	11.18	0.97
2020	sb2	53	86.95	78.69	79.15	8.77	16.19	12.54	0.95
2021	sb2	43	81.82	61.53	78.0	8.85	13.64	15.56	0.91
2022	sb2	41	81.68	56.88	77.35	8.07	7.66	14.07	0.93
2023	sb2	7	75.83	49.76	65.74	7.65	9.37	15.34	0.99
2010	ce2	194	85.91	76.08	88.95	5.47	9.3	5.25	0.92
2011	ce2	154	87.22	78.65	91.05	4.35	7.47	3.63	0.93
2012	ce2	170	88.17	80.08	91.25	5.64	9.89	5.2	0.94
2013	ce2	151	88.15	80.2	91.39	5.81	10.16	4.9	0.93
2014	ce2	113	90.44	84.06	92.99	6.66	11.8	6.39	0.94
2015	ce2	82	92.58	88.13	95.35	5.58	9.72	4.03	0.98
2016	ce2	65	91.94	87.23	95.14	5.45	9.3	3.84	0.96
2017	ce2	65	92.23	87.86	95.36	5.73	9.82	4.14	0.92
2018	ce2	78	90.06	84.24	93.94	6.54	11.53	5.14	0.92
2019	ce2	56	89.84	84.23	93.38	6.54	11.43	6.09	0.87
2020	ce2	53	86.42	78.69	92.19	9.14	16.19	7.72	0.9
2021	ce2	43	81.2	61.53	90.25	9.23	13.64	10.56	0.84
2022	ce2	41	81.09	56.88	90.77	8.48	7.66	10.04	0.85
2023	ce2	7	75.02	49.76	80.86	8.06	9.37	13.89	0.98
2010	cs2	194	85.27	76.08	−99.0	5.72	9.3	0.0	NaN
2011	cs2	154	86.63	78.65	−99.0	4.56	7.47	0.0	NaN
2012	cs2	170	87.63	80.08	−99.0	5.91	9.89	0.0	NaN
2013	cs2	151	87.6	80.2	−99.0	6.08	10.16	0.0	NaN
2014	cs2	113	90.01	84.06	−99.0	6.96	11.8	0.0	NaN
2015	cs2	82	92.24	88.13	−99.0	5.83	9.72	0.0	NaN
2016	cs2	65	91.56	87.23	−99.0	5.7	9.3	0.0	NaN
2017	cs2	65	91.87	87.86	−99.0	5.99	9.82	0.0	NaN

BYR	trait	n	rel_ss	rel_ebv	rel_cur	s_rel_ss	s_rel_ebv	s_rel_cur	cor
2018	cs2	78	89.59	84.24	−99.0	6.84	11.53	0.0	NaN
2019	cs2	56	89.35	84.23	−99.0	6.84	11.43	0.0	NaN
2020	cs2	53	85.76	78.69	−99.0	9.57	16.19	0.0	NaN
2021	cs2	43	80.42	61.53	−99.0	9.73	13.64	0.0	NaN
2022	cs2	41	80.39	56.88	−99.0	8.98	7.66	0.0	NaN
2023	cs2	7	73.98	49.76	−99.0	8.57	9.37	0.0	NaN

Table 18: Comparison of reliabilities between single-step and current official evaluation (two-step) for nordic genotyped bulls with no offspring

BYR	n	ss_rel	two_rel	s_ss_rel	s_two_rel	cor
2020	3083	54.841	77.688	0.0	1.282	5.19825e-14
2021	3046	54.841	77.552	0.0	1.251	3.89746e-14
2022	3107	54.841	77.504	0.0	1.394	4.7046e-14
2023	2982	54.841	76.936	0.0	1.891	9.3015e-15
2024	2941	54.841	76.743	0.0	1.48	−1.17386e-13
2025	1275	54.841	75.25	0.0	2.174	−2.24303e-14

Jersey

Genetic trends

Here, we exhibit the genetic trends of our evaluations for each trait. We see that the levels of breeding values are generally in agreement across evaluations.

Table 19: Genetic trends (Single-step (ss) vs new EBV (newebv) vs official EBV (offebv)) and correlation between single-step and official EBV for nordic AI bulls with at least 30 offspring in the full dataset

BYR	trait	n	m_ssm_newebv	m_offebv	s_ss	s_newebv	s_offebv	cor
2010	sb1	54	97.06	97.7	99.4	7.66	7.83	7.48	0.98
2011	sb1	47	96.06	96.55	98.17	8.45	8.66	8.33	0.98
2012	sb1	45	96.67	97.16	98.35	7.98	7.84	7.62	0.97
2013	sb1	43	95.14	95.74	96.86	8.44	8.88	8.42	0.98
2014	sb1	32	97.94	98.28	99.09	7.18	7.6	7.48	0.99
2015	sb1	30	97.9	97.83	98.19	6.51	6.59	6.53	1.0
2016	sb1	24	98.54	98.62	98.76	9.12	9.19	8.96	0.99
2017	sb1	29	98.86	98.9	98.84	8.77	8.89	8.6	0.99
2018	sb1	18	97.83	97.56	97.56	6.46	6.35	6.13	0.98

BYR	trait	n	m_ssm	m_newebv	m_offebv	s_ss	s_newebv	s_offebv	cor
2019	sb1	29	102.62	102.62	102.23	11.59	11.95	11.6	1.0
2020	sb1	22	100.41	99.68	99.2	9.85	10.4	9.92	0.99
2021	sb1	15	104.27	103.53	102.79	9.34	9.86	9.57	0.99
2022	sb1	16	106.31	105.38	104.66	8.59	8.97	8.63	1.0
2010	ce1	54	97.56	98.19	100.19	7.92	8.35	7.81	0.98
2011	ce1	47	96.49	97.02	99.0	7.86	8.24	7.76	0.98
2012	ce1	45	99.02	99.36	100.88	8.54	8.75	8.21	0.98
2013	ce1	43	94.07	94.51	96.15	8.06	8.39	7.74	0.98
2014	ce1	32	102.09	102.03	102.84	7.7	7.68	7.21	0.97
2015	ce1	30	101.3	101.23	101.5	8.93	8.98	8.6	0.99
2016	ce1	24	98.38	97.96	98.4	7.07	7.06	6.64	0.99
2017	ce1	29	100.1	100.07	99.94	8.25	8.44	8.0	0.98
2018	ce1	18	98.39	98.94	98.96	6.96	6.94	6.54	0.98
2019	ce1	29	99.41	99.72	99.12	6.99	7.14	6.54	1.0
2020	ce1	22	98.86	98.95	98.21	6.91	7.11	6.47	0.99
2021	ce1	15	104.8	104.87	103.81	6.58	6.9	6.35	0.99
2022	ce1	16	100.5	100.06	99.49	4.83	4.75	4.48	0.99
2010	cs1	54	96.87	96.83	96.86	6.5	6.44	6.44	0.99
2011	cs1	47	99.43	99.19	99.33	7.31	7.49	7.47	0.99
2012	cs1	45	97.91	97.84	97.88	6.7	6.77	6.86	0.99
2013	cs1	43	99.4	99.28	99.39	7.48	7.68	7.65	0.99
2014	cs1	32	95.66	95.72	95.77	6.49	6.62	6.62	1.0
2015	cs1	30	98.1	98.07	98.02	5.77	5.92	5.89	1.0
2016	cs1	24	101.17	101.29	101.31	5.2	5.02	5.07	0.99
2017	cs1	29	101.07	101.1	101.15	6.16	6.08	6.08	1.0
2018	cs1	18	101.28	101.11	101.23	3.95	3.89	3.88	0.99
2019	cs1	29	102.62	102.59	102.69	4.64	4.63	4.69	0.99
2020	cs1	22	100.45	100.41	100.41	5.28	5.29	5.27	1.0
2021	cs1	15	98.93	98.87	99.0	3.61	3.62	3.73	0.99
2022	cs1	16	100.75	100.62	100.73	3.8	4.29	4.18	0.99
2010	sb2	54	96.09	96.63	99.73	8.63	8.42	7.41	0.98
2011	sb2	47	93.89	94.64	97.87	8.45	8.65	7.65	0.98
2012	sb2	45	95.13	95.44	98.06	8.64	8.45	7.41	0.98

BYR	trait	n	m_ssm	m_newebv	m_offebv	s_ss	s_newebv	s_offebv	cor
2013	sb2	43	93.26	93.44	96.05	10.83	10.49	8.98	0.98
2014	sb2	32	94.62	94.81	97.07	7.01	7.12	6.15	0.98
2015	sb2	30	96.43	96.63	97.82	6.84	6.63	5.85	0.99
2016	sb2	24	94.92	94.92	96.14	10.24	10.14	8.92	0.99
2017	sb2	29	100.14	99.97	100.3	8.76	8.37	7.41	0.99
2018	sb2	18	99.0	98.67	99.05	8.39	8.39	7.2	0.98
2019	sb2	29	102.17	101.97	101.66	12.72	13.19	11.48	0.99
2020	sb2	22	103.0	102.23	101.57	11.75	12.25	10.78	1.0
2021	sb2	15	105.67	104.6	103.64	9.24	9.42	8.2	0.99
2022	sb2	16	107.62	106.94	105.58	10.69	11.06	9.61	0.99
2010	ce2	54	98.76	98.98	101.87	9.04	9.38	8.22	0.98
2011	ce2	47	96.7	97.06	100.01	8.44	9.1	7.91	0.98
2012	ce2	45	98.67	98.42	100.69	8.96	9.07	7.86	0.98
2013	ce2	43	94.95	95.0	97.39	9.08	9.17	7.92	0.98
2014	ce2	32	100.53	100.5	101.9	7.55	7.26	6.34	0.98
2015	ce2	30	101.33	101.33	101.76	7.25	7.16	6.44	0.99
2016	ce2	24	98.5	97.83	98.7	7.68	7.93	6.93	0.99
2017	ce2	29	99.55	99.59	99.84	10.26	10.44	9.25	0.99
2018	ce2	18	98.61	99.17	99.43	9.08	9.7	8.64	0.99
2019	ce2	29	99.55	99.55	99.2	8.84	9.23	7.89	0.99
2020	ce2	22	98.23	98.27	97.69	9.53	9.99	8.55	0.99
2021	ce2	15	104.6	104.73	103.46	6.84	6.94	6.24	0.99
2022	ce2	16	100.06	100.06	99.3	8.48	8.4	7.33	0.99
2010	cs2	54	97.87	97.72	97.55	6.04	6.09	6.13	1.0
2011	cs2	47	99.0	98.83	98.72	7.3	7.42	7.39	1.0
2012	cs2	45	98.18	98.13	97.91	7.07	7.21	7.12	1.0
2013	cs2	43	99.26	99.16	98.99	6.9	7.09	7.1	1.0
2014	cs2	32	96.0	95.91	95.9	6.98	7.1	7.16	1.0
2015	cs2	30	97.43	97.37	97.45	6.36	6.31	6.34	1.0
2016	cs2	24	99.67	99.79	99.91	6.13	6.09	6.1	1.0
2017	cs2	29	100.9	100.97	101.14	6.41	6.44	6.37	1.0
2018	cs2	18	98.89	98.61	98.83	3.91	4.06	4.06	0.99
2019	cs2	29	103.0	103.03	103.24	4.81	4.78	4.79	1.0

BYR	trait	n	m_ssm_newebv	m_offebv	s_ss	s_newebv	s_offebv	cor
2020	cs2	22	101.27	101.27	101.43	5.09	5.16	5.03	1.0
2021	cs2	15	100.07	99.73	100.01	4.3	4.03	4.17	0.99
2022	cs2	16	99.75	99.44	99.36	4.68	4.84	4.82	1.0

Table 20: Genetic trends (Single-step full dataset (f) vs single-step reduced dataset (r)) for nordic AI bulls with at least 30 offspring in the full dataset

BYR	trait	n	m_f	m_r	s_f	s_r	m_diff	cor
2010	sb1	54	98.59	98.63	7.86	8.05	0.78	0.99
2011	sb1	47	97.6	97.89	8.71	8.43	0.94	0.98
2012	sb1	45	98.38	98.33	8.14	7.99	0.84	0.99
2013	sb1	43	96.74	96.91	8.71	8.63	0.86	0.99
2014	sb1	32	99.59	99.31	7.3	7.91	1.03	0.98
2015	sb1	30	99.53	99.37	6.79	6.79	1.03	0.98
2016	sb1	24	100.25	100.17	9.26	9.58	1.33	0.98
2017	sb1	29	100.55	100.62	9.05	9.03	2.07	0.96
2018	sb1	18	99.39	98.11	6.75	4.91	4.94	0.56
2019	sb1	29	104.45	100.38	11.78	6.45	9.17	0.52
2020	sb1	22	102.0	99.27	9.99	4.58	7.18	0.4
2021	sb1	15	106.07	101.13	9.53	4.21	6.8	0.54
2022	sb1	16	108.06	102.31	8.86	3.75	10.12	−0.28
2023	sb1	2	99.0	95.0	4.24	5.66	4.0	1.0
2010	ce1	54	99.24	99.31	7.96	8.21	0.63	0.99
2011	ce1	47	98.04	98.21	7.83	7.88	0.64	0.99
2012	ce1	45	100.69	100.82	8.49	8.52	0.53	0.99
2013	ce1	43	95.79	95.63	8.0	7.98	0.81	0.99
2014	ce1	32	103.72	103.28	7.57	7.87	1.0	0.99
2015	ce1	30	102.9	102.5	8.77	9.05	0.87	0.99
2016	ce1	24	100.08	100.46	6.94	6.7	1.54	0.96
2017	ce1	29	101.86	100.9	8.13	8.36	1.72	0.96
2018	ce1	18	100.22	101.0	6.9	4.9	4.33	0.56
2019	ce1	29	100.97	98.52	7.03	5.65	5.14	0.59
2020	ce1	22	100.32	100.05	6.73	4.29	4.18	0.5
2021	ce1	15	106.27	100.93	6.68	4.88	7.33	0.28
2022	ce1	16	101.94	102.0	4.51	2.58	4.19	−0.05

BYR	trait	n	m_f	m_r	s_f	s_r	m_diff	cor
2023	ce1	2	97.0	97.5	4.24	0.71	2.5	1.0
2010	cs1	54	96.87	96.8	6.5	6.46	0.19	1.0
2011	cs1	47	99.4	99.47	7.33	7.35	0.4	1.0
2012	cs1	45	97.89	97.82	6.68	6.67	0.38	1.0
2013	cs1	43	99.37	99.12	7.45	7.56	0.49	1.0
2014	cs1	32	95.62	95.34	6.48	6.65	0.47	0.99
2015	cs1	30	98.03	97.97	5.8	5.85	0.33	1.0
2016	cs1	24	101.12	100.88	5.19	5.14	0.42	0.99
2017	cs1	29	101.07	100.9	6.16	6.18	0.59	0.99
2018	cs1	18	101.22	101.39	3.95	3.16	2.94	0.4
2019	cs1	29	102.62	101.79	4.64	4.24	2.9	0.63
2020	cs1	22	100.41	100.73	5.22	3.28	3.5	0.53
2021	cs1	15	98.93	99.67	3.61	2.82	2.87	0.4
2022	cs1	16	100.69	100.56	3.91	3.22	4.0	0.16
2023	cs1	2	99.5	104.5	3.54	2.12	5.0	−1.0
2010	sb2	54	98.52	98.43	9.38	9.32	0.94	0.99
2011	sb2	47	96.21	96.6	9.15	9.06	1.19	0.98
2012	sb2	45	97.58	97.62	9.35	9.13	0.93	0.99
2013	sb2	43	95.51	95.28	11.71	11.19	1.16	0.99
2014	sb2	32	96.91	96.5	7.46	7.55	1.59	0.97
2015	sb2	30	99.03	99.43	7.52	7.37	1.6	0.96
2016	sb2	24	97.29	96.46	10.98	11.23	2.08	0.97
2017	sb2	29	102.9	102.34	9.38	9.57	2.0	0.96
2018	sb2	18	101.61	96.11	9.03	6.32	8.17	0.43
2019	sb2	29	105.17	101.62	13.85	6.06	9.69	0.52
2020	sb2	22	105.91	98.86	12.79	5.33	11.77	0.26
2021	sb2	15	108.93	101.6	9.81	4.29	8.8	0.7
2022	sb2	16	111.19	103.31	11.58	3.96	12.62	−0.18
2023	sb2	2	105.5	97.5	0.71	2.12	8.0	1.0
2010	ce2	54	100.63	100.91	9.56	9.89	0.91	0.99
2011	ce2	47	98.43	98.43	9.01	9.39	0.77	0.99
2012	ce2	45	100.51	100.76	9.47	9.53	1.0	0.99
2013	ce2	43	96.56	96.53	9.52	9.78	1.14	0.99

BYR	trait	n	m_f	m_r	s_f	s_r	m_diff	cor
2014	ce2	32	102.41	101.69	8.02	7.98	1.22	0.98
2015	ce2	30	103.3	103.3	7.68	7.73	0.87	0.99
2016	ce2	24	100.25	100.25	8.16	8.11	1.5	0.97
2017	ce2	29	101.31	100.83	10.85	10.44	1.79	0.96
2018	ce2	18	100.56	100.39	9.59	4.69	7.39	0.35
2019	ce2	29	101.38	100.1	9.36	6.87	6.45	0.59
2020	ce2	22	100.05	99.36	10.34	5.01	6.59	0.56
2021	ce2	15	106.67	101.4	7.02	5.37	7.93	−0.1
2022	ce2	16	101.88	102.38	9.05	3.2	6.0	0.29
2023	ce2	2	97.5	99.0	0.71	1.41	1.5	1.0
2010	cs2	54	97.46	97.56	6.06	6.0	0.17	1.0
2011	cs2	47	98.66	98.74	7.37	7.36	0.21	1.0
2012	cs2	45	97.8	97.87	6.98	7.0	0.33	1.0
2013	cs2	43	98.86	98.81	6.85	6.92	0.28	1.0
2014	cs2	32	95.66	95.5	7.01	7.2	0.34	1.0
2015	cs2	30	97.1	96.97	6.26	6.36	0.27	1.0
2016	cs2	24	99.33	99.25	6.1	6.1	0.33	1.0
2017	cs2	29	100.76	100.07	6.27	6.46	0.69	1.0
2018	cs2	18	98.44	98.89	3.76	3.88	3.67	0.29
2019	cs2	29	102.55	100.97	4.76	4.07	3.38	0.68
2020	cs2	22	101.05	99.95	4.97	3.24	3.91	0.34
2021	cs2	15	99.67	99.0	4.15	3.38	2.93	0.47
2022	cs2	16	99.31	100.0	4.77	3.03	4.19	0.06
2023	cs2	2	103.5	102.0	2.12	2.83	1.5	1.0

Table 21: Genetic trends (Single-step full dataset (f) vs single-step reduced dataset (r)) for nordic cows with genotype and phenotype

BYR	trait	n	m_f	m_r	s_f	s_r	m_diff	cor
2010	sb1	2359	96.53	96.32	4.22	4.13	1.26	0.93
2011	sb1	4376	96.67	96.38	4.3	4.22	1.2	0.94
2012	sb1	4992	98.05	97.73	4.56	4.35	1.21	0.94
2013	sb1	3930	98.14	97.89	4.17	3.96	1.2	0.93
2014	sb1	4927	97.89	97.75	4.59	4.45	1.16	0.94
2015	sb1	5881	98.13	97.94	5.07	4.9	1.16	0.95

BYR	trait	n	m_f	m_r	s_f	s_r	m_diff	cor
2016	sb1	7041	98.79	98.61	5.33	5.18	1.19	0.96
2017	sb1	8758	97.99	97.87	4.95	4.87	1.23	0.95
2018	sb1	10788	99.12	98.72	4.86	4.74	1.28	0.94
2019	sb1	13215	99.15	99.28	5.71	5.74	1.46	0.94
2020	sb1	16111	98.95	98.69	5.77	5.35	2.14	0.88
2021	sb1	15718	102.27	100.25	6.04	4.66	3.65	0.76
2022	sb1	16522	102.12	99.12	5.64	4.23	4.04	0.73
2023	sb1	16230	102.87	99.88	5.78	4.07	3.92	0.75
2024	sb1	16949	104.73	100.3	5.77	3.82	5.5	0.56
2025	sb1	5605	104.19	100.46	5.86	3.75	5.87	0.34
2010	ce1	2359	98.92	98.97	4.02	4.04	1.02	0.94
2011	ce1	4376	98.86	98.93	4.16	4.11	0.98	0.95
2012	ce1	4992	99.79	99.84	4.66	4.57	0.98	0.96
2013	ce1	3930	100.29	100.31	4.4	4.33	0.99	0.95
2014	ce1	4927	100.68	100.66	4.73	4.65	1.0	0.96
2015	ce1	5881	100.09	100.05	5.01	4.96	1.02	0.96
2016	ce1	7041	101.79	101.82	4.98	4.9	1.0	0.96
2017	ce1	8758	100.83	100.67	5.87	5.92	1.06	0.97
2018	ce1	10788	101.48	101.59	4.38	4.39	1.06	0.95
2019	ce1	13215	100.89	100.57	4.81	4.84	1.23	0.95
2020	ce1	16111	101.28	101.16	4.75	4.43	1.5	0.91
2021	ce1	15718	101.88	100.64	4.66	4.39	2.71	0.76
2022	ce1	16522	102.05	100.4	4.13	3.83	2.57	0.76
2023	ce1	16230	102.34	100.97	4.21	3.68	2.66	0.7
2024	ce1	16949	103.8	100.74	4.11	3.34	3.63	0.6
2025	ce1	5605	101.95	100.94	3.78	3.03	2.65	0.57
2010	cs1	2359	98.1	98.18	3.83	3.83	0.62	0.97
2011	cs1	4376	98.02	98.13	4.03	4.0	0.62	0.98
2012	cs1	4992	98.14	98.25	4.15	4.11	0.64	0.98
2013	cs1	3930	97.55	97.56	3.89	3.81	0.61	0.97
2014	cs1	4927	97.06	97.12	3.92	3.89	0.63	0.97
2015	cs1	5881	98.36	98.36	5.28	5.26	0.61	0.99
2016	cs1	7041	97.34	97.35	4.43	4.44	0.61	0.98

BYR	trait	n	m_f	m_r	s_f	s_r	m_diff	cor
2017	cs1	8758	97.87	97.92	4.37	4.37	0.61	0.98
2018	cs1	10788	98.71	98.72	3.67	3.66	0.61	0.97
2019	cs1	13215	99.37	99.27	3.7	3.71	0.66	0.97
2020	cs1	16111	99.14	99.24	3.54	3.54	0.86	0.94
2021	cs1	15718	100.14	100.04	3.34	3.09	1.46	0.82
2022	cs1	16522	100.28	100.0	3.1	3.01	1.44	0.81
2023	cs1	16230	99.74	99.88	3.35	2.69	1.85	0.68
2024	cs1	16949	100.12	100.45	2.98	2.57	1.98	0.6
2025	cs1	5605	100.32	100.38	2.9	2.63	2.09	0.56
2010	sb2	2359	95.43	95.27	4.44	4.1	1.62	0.89
2011	sb2	4376	95.53	95.28	4.58	4.38	1.59	0.9
2012	sb2	4992	96.52	96.3	4.76	4.48	1.54	0.91
2013	sb2	3930	96.74	96.54	4.64	4.36	1.57	0.9
2014	sb2	4927	96.64	96.5	4.63	4.38	1.54	0.9
2015	sb2	5881	98.04	97.85	5.5	5.25	1.53	0.93
2016	sb2	7041	97.17	96.83	5.21	4.91	1.62	0.92
2017	sb2	8758	97.2	97.23	5.44	5.16	1.64	0.92
2018	sb2	10788	98.76	98.28	5.04	4.74	1.73	0.9
2019	sb2	13215	98.96	98.61	6.57	6.48	1.78	0.94
2020	sb2	16111	100.27	98.99	6.44	5.88	2.79	0.82
2021	sb2	15718	102.52	99.78	6.34	5.19	4.37	0.69
2022	sb2	16522	103.77	100.16	6.65	4.54	5.14	0.66
2023	sb2	16230	104.69	99.67	7.03	4.87	6.13	0.65
2024	sb2	16949	107.25	100.81	7.58	4.29	7.9	0.57
2025	sb2	5605	107.48	101.15	7.01	4.19	7.74	0.41
2010	ce2	2359	99.76	99.83	4.46	4.35	1.45	0.91
2011	ce2	4376	99.59	99.63	4.57	4.45	1.4	0.92
2012	ce2	4992	99.9	99.97	4.94	4.8	1.41	0.93
2013	ce2	3930	100.56	100.71	4.73	4.63	1.42	0.92
2014	ce2	4927	100.97	101.04	5.03	4.82	1.47	0.93
2015	ce2	5881	100.32	100.29	4.9	4.74	1.43	0.93
2016	ce2	7041	101.61	101.49	4.73	4.56	1.43	0.92
2017	ce2	8758	101.22	101.26	5.25	5.01	1.46	0.93

BYR	trait	n	m_f	m_r	s_f	s_r	m_diff	cor
2018	ce2	10788	100.65	100.78	4.23	4.06	1.51	0.89
2019	ce2	13215	100.65	100.77	5.55	5.1	1.61	0.93
2020	ce2	16111	101.63	101.48	5.35	4.54	2.25	0.83
2021	ce2	15718	101.8	100.99	5.33	4.56	2.95	0.73
2022	ce2	16522	102.24	100.88	5.3	4.26	3.44	0.65
2023	ce2	16230	102.53	101.17	5.51	4.22	3.93	0.55
2024	ce2	16949	104.77	101.18	5.4	3.77	4.78	0.46
2025	ce2	5605	102.99	101.46	5.41	3.54	4.06	0.47
2010	cs2	2359	97.71	97.79	3.75	3.82	0.66	0.97
2011	cs2	4376	97.65	97.71	4.11	4.17	0.64	0.98
2012	cs2	4992	98.01	98.05	4.1	4.12	0.65	0.98
2013	cs2	3930	97.39	97.35	3.78	3.79	0.63	0.97
2014	cs2	4927	96.58	96.58	4.08	4.11	0.65	0.98
2015	cs2	5881	98.1	98.11	5.28	5.29	0.63	0.99
2016	cs2	7041	96.95	96.94	4.53	4.54	0.63	0.98
2017	cs2	8758	97.76	97.7	4.25	4.24	0.63	0.98
2018	cs2	10788	98.06	97.95	3.64	3.66	0.65	0.97
2019	cs2	13215	98.88	98.66	3.44	3.4	0.68	0.96
2020	cs2	16111	98.71	98.51	3.48	3.46	1.01	0.92
2021	cs2	15718	99.7	99.29	3.51	3.11	1.69	0.81
2022	cs2	16522	100.05	99.22	3.28	2.98	1.75	0.79
2023	cs2	16230	99.5	99.13	3.41	2.79	2.01	0.69
2024	cs2	16949	99.85	99.7	3.17	2.66	2.1	0.58
2025	cs2	5605	99.66	99.58	3.09	2.61	1.94	0.61

Correlations

Here, we give correlation tables and tables of differences between the relevant evaluations. We test that we didn't change the model by comparing our new model without genomic information to the breeding values of the traditional pedigree-based model and expect very high correlations for tested animals. We test the change by incorporating genomic information, compared to a non-genomic evaluation, and expect to see some changes even in tested animals, but not too large.

Table 22: Correlations between current EBV and new EBV for Nordic AI bulls with > 30 offspring

BYR	n	cor1	cor2	cor3	cor4	cor5	cor6
2009	50	0.996	0.994	0.999	0.995	0.996	1.0
2010	54	0.996	0.997	0.999	0.996	0.996	0.999
2011	47	0.998	0.997	0.999	0.996	0.998	0.999
2012	45	0.998	0.996	0.999	0.997	0.996	0.999
2013	43	0.998	0.997	0.999	0.998	0.996	0.999
2014	32	0.999	0.997	0.999	0.996	0.996	0.999
2015	30	0.999	0.998	0.999	0.997	0.998	0.999
2016	24	0.998	0.997	0.999	0.999	0.997	0.999
2017	29	0.999	0.999	0.999	0.998	0.998	0.999
2018	18	0.999	0.997	0.997	0.998	0.998	0.997
2019	29	0.999	0.998	0.997	1.0	0.998	0.998
2020	22	0.999	0.999	0.998	0.999	0.998	0.999
2021	15	0.999	0.998	0.998	0.998	0.995	0.998
2022	16	1.0	0.997	0.997	0.999	0.999	0.998

Table 23: Table of differences between current EBV and new EBV for Nordic AI bulls with > 30 offspring born after 2015

dif	dif1	dif2	dif3	dif4	dif5	dif6
−4.0	0	0	0	3	0	0
−3.0	0	0	0	8	6	0
−2.0	3	10	0	21	19	0
−1.0	48	63	1	31	39	1
0.0	87	55	139	28	49	132
1.0	16	25	15	39	23	22
2.0	1	2	0	16	11	0
3.0	0	0	0	8	7	0
4.0	0	0	0	0	1	0
5.0	0	0	0	1	0	0

Table 24: Correlations between current EBV and new Single-step for AI bulls with > 30 offspring

BYR	n	cor1	cor2	cor3	cor4	cor5	cor6
2009	50	0.982	0.98	0.997	0.978	0.991	0.999
2010	54	0.98	0.983	0.995	0.981	0.979	0.996
2011	47	0.981	0.982	0.994	0.979	0.983	0.998

BYR	n	cor1	cor2	cor3	cor4	cor5	cor6
2012	45	0.97	0.982	0.994	0.977	0.984	0.998
2013	43	0.981	0.979	0.994	0.984	0.981	0.996
2014	32	0.992	0.971	0.995	0.981	0.978	0.998
2015	30	0.996	0.994	0.995	0.986	0.994	0.998
2016	24	0.991	0.99	0.994	0.99	0.993	0.998
2017	29	0.993	0.985	0.998	0.992	0.992	0.999
2018	18	0.984	0.978	0.988	0.985	0.987	0.993
2019	29	0.996	0.996	0.992	0.994	0.991	0.995
2020	22	0.994	0.989	0.998	0.997	0.994	0.998
2021	15	0.99	0.989	0.991	0.985	0.986	0.994
2022	16	0.998	0.987	0.994	0.987	0.994	0.997

Table 25: Table of differences between current EBV and new Single-step for AI bulls with > 30 offspring born after 2015

dif	dif1	dif2	dif3	dif4	dif5	dif6
−5.0	1	0	0	2	0	0
−4.0	1	0	0	11	0	0
−3.0	2	1	0	10	10	0
−2.0	27	27	1	26	22	0
−1.0	48	43	12	28	30	12
0.0	53	56	120	29	41	118
1.0	15	12	20	24	32	24
2.0	5	13	2	14	13	1
3.0	1	2	0	7	6	0
4.0	2	1	0	2	1	0
5.0	0	0	0	1	0	0
6.0	0	0	0	0	0	0
7.0	0	0	0	1	0	0

Legarra-Reverter test

The Legarra-Reverter test is a test for bias in evaluations. We perform two calculations of breeding values, one with all information available and one where offspring of sires born after 2018 has their records removed. Then we perform a linear regression on genotyped, nordic bulls, who has no data in the reduced dataset and with more than 30 offspring in the full dataset. We also require that their sires are not in the focal group, so we remove bulls whose father meets the same criteria.

The slope of the regression indicates the bias, with a slope of one meaning no bias, a slope less than one indicating that the estimated values of unproven animals are too extreme, and a slope higher than one indicating that the estimated breeding values of unproven animals are too conservative.

As can be seen, we have some issues with the Legarra-Reverter test. We're looking into it.

Table 26: Legarra-Reverter scores
Singlestep:

trait	b1	rsquare	n
nysb1	1.001	0.363	52
nyce1	0.714	0.289	52
nycs1	0.663	0.302	51
nysb2	0.923	0.219	58
nyce2	0.878	0.252	58
nycs2	0.742	0.386	58

EBV:

trait	b1	rsquare	n
nysb1	0.89	0.258	52
nyce1	0.641	0.221	52
nycs1	0.55	0.182	51
nysb2	0.614	0.099	58
nyce2	0.89	0.211	58
nycs2	0.73	0.317	58

Interbull test

An Interbull GEBV test was performed. We failed.

```
735 brd pop trt evaldate m ntest    mean_y     std_y dv    mean_x     std_x        b0     se_b0      b1   se_b1 ncand
i_est  Exp_b1   R2 fb year  tests  pass
735 JER DFS sb1 20250904 1    36   99.6483   15.1330 GM   98.2578    5.4846   30.7532   40.4106  0.7025  0.3598    36
0.0000  1.0000  7.9  N 2015   YNN-  hiSE
735 JER DFS sb1 20250904 2    36   99.6483   15.1330 GM   97.7887    5.5119   56.2646   41.0800  0.4438  0.4199    36
0.0000  1.0000  3.2  N 2015   ----  ----
735 JER DFS ce1 20250904 1    38   99.7853   10.4720 GM   99.0853    4.7184   43.2817   31.8131  0.5721  0.2929    38
0.0000  1.0000  8.1  N 2015   YNN-  hiSE
735 JER DFS ce1 20250904 2    38   99.7853   10.4720 GM   99.5816    4.8943   56.6102   31.6093  0.4352  0.3169    38
0.0000  1.0000  5.0  N 2015   ----  ----
735 JER DFS cs1 20250904 1    37  101.7903    5.3307 GM  101.4644    3.6303   59.3291   23.8737  0.4177  0.2167    37
0.0000  1.0000  8.3  N 2015   NNN-  FAIL
735 JER DFS cs1 20250904 2    37  101.7903    5.3307 GM  100.8203    3.6166   71.1283   23.9118  0.3036  0.2373    37
0.0000  1.0000  4.5  N 2015   ----  ----
735 JER DFS sb2 20250904 1    35  100.9666   19.4341 GM   98.9147    5.3520   34.1546   56.0799  0.6710  0.4026    35
0.0000  1.0000  4.1  N 2015   YNN-  hiSE
735 JER DFS sb2 20250904 2    35  100.9666   19.4341 GM   98.7746    5.7332   75.1380   52.0435  0.2573  0.5243    35
0.0000  1.0000  0.7  N 2015   ----  ----
735 JER DFS ce2 20250904 1    36   99.1086   16.7941 GM   99.4957    5.9532    9.5020   42.0424  0.9015  0.3751    36
0.0000  1.0000 11.8  N 2015   YYY-  PASS
735 JER DFS ce2 20250904 2    36   99.1086   16.7941 GM  100.5904    6.0477   17.1291   41.9707  0.8143  0.4168    36
0.0000  1.0000 10.1  N 2015   ----  ----
735 JER DFS cs2 20250904 1    36  102.0925    5.2371 GM  100.3217    4.0027   47.2446   21.1748  0.5453  0.1916    36
0.0000  1.0000 16.4  N 2015   NNN-  FAIL
735 JER DFS cs2 20250904 2    36  102.0925    5.2371 GM   99.8518    3.6757   58.0090   23.4046  0.4402  0.2342    36
0.0000  1.0000  9.4  N 2015   ----  ----

NOTE: pass=hiSE indicates an inconclusive statistical PASS due to high SE(b1) while FAILING the practical test: b1<0.8 or
b1>1.2
```

The set of bulls chosen by the Interbull test program is different from the focal group selected for the Legarra-Reverter test. Hence, we get different slope coefficients.

Mendelian sampling

The mendelian sampling of an animals is its deviation of its breeding values from the expected breeding value, which is the average of its parents breeding values. Some mendelian samling is expected on the individual level (this is what enables breeding), but across all animals we expect it to be close to zero. Otherwise, this indicates a bias in the set of animals in the evaluation, which violates the unbiasedness of the BLUP model. We conclude that the mendelian sampling is generally close to 0.

Table 27: Average mendelian sampling by birth year. Animals are only included if they are genotyped, their sire has > 30 offspring and their dam is genotyped.

BYR	m1	m2	m3	m4	m5	m6
2010	1.31	−0.278	−0.132	1.602	−0.398	0.208
2011	0.967	−0.085	0.451	0.672	−0.357	0.425
2012	0.23	−0.367	0.881	0.636	−0.167	1.145
2013	−0.16	−0.713	0.319	0.049	−0.707	0.512
2014	−0.061	−0.278	0.24	−0.047	−0.233	0.259
2015	−0.014	0.03	0.039	0.042	0.045	0.058
2016	0.056	0.069	−0.087	0.084	0.011	−0.086
2017	0.049	0.013	−0.037	0.06	0.022	−0.02
2018	0.051	−0.023	0.025	0.066	−0.147	−0.009
2019	−0.094	0.039	−0.003	−0.011	−0.022	−0.196
2020	0.02	−0.029	0.033	0.007	−0.064	−0.15
2021	0.055	0.021	−0.019	0.144	−0.021	−0.053
2022	0.12	0.114	−0.025	0.142	0.061	−0.024
2023	0.044	0.079	−0.024	0.111	0.032	0.005
2024	0.031	0.049	0.018	0.085	−0.019	0.036

Table 28: Average mendelian sampling by birth year. Animals are only included if they are not genotyped, their sire has > 30 offspring and their dam isn't genotyped.

BYR	m1	m2	m3	m4	m5	m6
2001	−0.035	−0.037	0.025	0.066	0.002	0.002
2002	−0.008	−0.051	−0.013	0.037	−0.017	0.012
2003	−0.033	−0.023	0.012	−0.008	−0.001	0.021
2004	−0.021	−0.053	−0.006	−0.03	0.016	0.033
2005	−0.025	−0.054	0.017	0.053	0.006	0.045
2006	−0.005	−0.02	0.028	0.034	−0.012	0.064
2007	−0.017	−0.067	0.035	0.06	−0.04	0.018
2008	−0.044	−0.031	0.009	0.06	−0.023	0.058

BYR	m1	m2	m3	m4	m5	m6
2009	−0.048	−0.018	0.008	0.038	−0.007	0.037
2010	−0.025	0.006	−0.052	−0.043	0.002	−0.005
2011	−0.065	0.007	−0.033	−0.028	0.023	−0.045
2012	−0.065	−0.027	−0.025	−0.025	0.049	−0.051
2013	−0.055	0.008	−0.03	−0.018	0.027	−0.024
2014	−0.033	0.008	−0.03	−0.052	−0.013	−0.031
2015	−0.042	0.008	−0.006	−0.046	−0.033	−0.015
2016	−0.055	−0.011	−0.039	−0.052	−0.066	−0.025
2017	−0.023	0.007	−0.032	−0.022	0.014	0.011
2018	−0.086	−0.026	−0.053	−0.051	−0.05	−0.05
2019	−0.044	−0.012	−0.003	−0.031	−0.016	−0.046
2020	0.047	−0.001	−0.011	0.001	0.036	−0.077
2021	−0.028	−0.061	0.017	0.002	−0.097	0.006
2022	−0.007	0.018	0.008	−0.012	−0.043	0.021
2023	−0.002	0.054	−0.012	0.015	0.008	0.013
2024	−0.033	0.034	−0.021	−0.031	−0.022	−0.003

Reliabilities

Table 29: Comparison of reliabilties between single-step (ss), new EBV (ebv) and current official evaluation (cur) for nordic AI bulls with > 30 offspring

BYR	trait	n	rel_ss	rel_ebv	rel_cur	s_rel_ss	s_rel_ebv	s_rel_cur	cor
2010	sb1	54	70.1	64.74	68.31	9.24	11.59	11.05	0.99
2011	sb1	47	68.76	63.14	67.22	8.65	10.88	10.4	0.99
2012	sb1	45	70.39	64.49	67.85	11.27	14.05	13.17	1.0
2013	sb1	43	68.75	62.22	65.6	11.7	15.07	14.24	1.0
2014	sb1	32	74.51	69.69	72.73	14.02	18.04	16.94	1.0
2015	sb1	30	84.23	82.02	84.3	11.9	14.76	13.53	1.0
2016	sb1	24	80.96	78.02	80.2	12.25	15.19	14.23	1.0
2017	sb1	29	85.86	84.0	86.4	11.26	13.69	12.44	1.0
2018	sb1	18	75.95	71.36	75.29	15.52	19.77	17.82	0.99
2019	sb1	29	84.69	82.32	85.63	11.4	15.05	13.34	0.99
2020	sb1	22	82.93	80.14	87.15	11.48	15.57	12.96	0.91
2021	sb1	15	69.65	62.42	81.87	9.2	14.62	18.83	0.8
2022	sb1	16	67.51	61.11	85.17	4.65	5.78	9.01	0.93

BYR	trait	n	rel_ss	rel_ebv	rel_cur	s_rel_ss	s_rel_ebv	s_rel_cur	cor
2023	sb1	2	57.29	46.21	61.25	12.52	17.83	27.65	1.0
2010	ce1	54	69.99	64.74	66.62	9.27	11.59	10.43	0.99
2011	ce1	47	68.64	63.14	65.48	8.68	10.88	9.71	0.99
2012	ce1	45	70.28	64.49	66.19	11.31	14.05	12.79	1.0
2013	ce1	43	68.63	62.22	64.18	11.75	15.07	13.57	0.99
2014	ce1	32	74.41	69.69	70.84	14.07	18.04	16.19	1.0
2015	ce1	30	84.17	82.02	82.02	11.94	14.76	13.6	1.0
2016	ce1	24	80.89	78.02	77.87	12.29	15.19	13.65	1.0
2017	ce1	29	85.8	84.0	84.09	11.3	13.69	12.42	1.0
2018	ce1	18	75.86	71.36	73.11	15.57	19.77	17.63	1.0
2019	ce1	29	84.63	82.32	82.56	11.45	15.05	14.16	1.0
2020	ce1	22	82.86	80.14	83.92	11.53	15.57	13.81	0.92
2021	ce1	15	69.52	62.42	78.47	9.25	14.62	19.05	0.82
2022	ce1	16	67.38	61.11	81.2	4.67	5.78	9.91	0.94
2023	ce1	2	57.13	46.21	56.6	12.56	17.83	26.45	1.0
2010	cs1	54	68.34	64.74	−99.0	9.74	11.59	0.0	NaN
2011	cs1	47	66.93	63.14	−99.0	9.12	10.88	0.0	NaN
2012	cs1	45	68.66	64.49	−99.0	11.9	14.05	0.0	NaN
2013	cs1	43	66.9	62.22	−99.0	12.36	15.07	0.0	NaN
2014	cs1	32	72.98	69.69	−99.0	14.81	18.04	0.0	NaN
2015	cs1	30	83.27	82.02	−99.0	12.6	14.76	0.0	NaN
2016	cs1	24	79.81	78.02	−99.0	12.98	15.19	0.0	NaN
2017	cs1	29	84.97	84.0	−99.0	11.93	13.69	0.0	NaN
2018	cs1	18	74.5	71.36	−99.0	16.4	19.77	0.0	NaN
2019	cs1	29	83.69	82.32	−99.0	12.13	15.05	0.0	NaN
2020	cs1	22	81.8	80.14	−99.0	12.2	15.57	0.0	NaN
2021	cs1	15	67.59	62.42	−99.0	9.9	14.62	0.0	NaN
2022	cs1	16	65.46	61.11	−99.0	4.93	5.78	0.0	NaN
2023	cs1	2	54.83	46.21	−99.0	13.15	17.83	0.0	NaN
2010	sb2	54	70.48	64.74	70.1	9.13	11.59	10.03	0.99
2011	sb2	47	69.15	63.14	68.82	8.55	10.88	9.11	0.98
2012	sb2	45	70.76	64.49	69.51	11.14	14.05	11.96	0.99
2013	sb2	43	69.15	62.22	68.2	11.56	15.07	12.57	0.99

BYR	trait	n	rel_ss	rel_ebv	rel_cur	s_rel_ss	s_rel_ebv	s_rel_cur	cor
2014	sb2	32	74.84	69.69	74.29	13.85	18.04	15.19	0.99
2015	sb2	30	84.44	82.02	84.72	11.75	14.76	11.63	0.99
2016	sb2	24	81.21	78.02	81.18	12.09	15.19	11.9	0.99
2017	sb2	29	86.05	84.0	85.77	11.11	13.69	10.65	0.99
2018	sb2	18	76.27	71.36	75.15	15.32	19.77	15.26	0.99
2019	sb2	29	84.91	82.32	82.44	11.25	15.05	12.73	0.99
2020	sb2	22	83.18	80.14	81.76	11.33	15.57	13.52	0.92
2021	sb2	15	70.1	62.42	76.07	9.06	14.62	18.51	0.82
2022	sb2	16	67.95	61.11	78.24	4.59	5.78	9.91	0.94
2023	sb2	2	57.83	46.21	53.25	12.38	17.83	24.11	1.0
2010	ce2	54	70.18	64.74	74.05	9.22	11.59	9.67	0.98
2011	ce2	47	68.84	63.14	72.83	8.63	10.88	8.83	0.98
2012	ce2	45	70.47	64.49	73.2	11.24	14.05	11.2	0.99
2013	ce2	43	68.83	62.22	72.29	11.67	15.07	11.74	0.98
2014	ce2	32	74.58	69.69	77.91	13.99	18.04	14.2	0.99
2015	ce2	30	84.28	82.02	87.36	11.87	14.76	10.79	0.98
2016	ce2	24	81.01	78.02	84.34	12.21	15.19	10.94	0.99
2017	ce2	29	85.9	84.0	88.5	11.23	13.69	9.89	0.99
2018	ce2	18	76.02	71.36	78.32	15.48	19.77	14.41	0.99
2019	ce2	29	84.74	82.32	84.79	11.37	15.05	12.93	0.99
2020	ce2	22	82.98	80.14	84.23	11.45	15.57	14.15	0.91
2021	ce2	15	69.74	62.42	78.68	9.17	14.62	19.49	0.8
2022	ce2	16	67.6	61.11	81.04	4.64	5.78	9.93	0.94
2023	ce2	2	57.4	46.21	54.2	12.49	17.83	26.02	1.0
2010	cs2	54	68.23	64.74	−99.0	9.77	11.59	0.0	NaN
2011	cs2	47	66.81	63.14	−99.0	9.15	10.88	0.0	NaN
2012	cs2	45	68.54	64.49	−99.0	11.94	14.05	0.0	NaN
2013	cs2	43	66.78	62.22	−99.0	12.41	15.07	0.0	NaN
2014	cs2	32	72.88	69.69	−99.0	14.86	18.04	0.0	NaN
2015	cs2	30	83.2	82.02	−99.0	12.64	14.76	0.0	NaN
2016	cs2	24	79.73	78.02	−99.0	13.03	15.19	0.0	NaN
2017	cs2	29	84.91	84.0	−99.0	11.98	13.69	0.0	NaN
2018	cs2	18	74.4	71.36	−99.0	16.46	19.77	0.0	NaN

BYR	trait	n	rel_ss	rel_ebv	rel_cur	s_rel_ss	s_rel_ebv	s_rel_cur	cor
2019	cs2	29	83.62	82.32	−99.0	12.18	15.05	0.0	NaN
2020	cs2	22	81.73	80.14	−99.0	12.24	15.57	0.0	NaN
2021	cs2	15	67.45	62.42	−99.0	9.95	14.62	0.0	NaN
2022	cs2	16	65.32	61.11	−99.0	4.95	5.78	0.0	NaN
2023	cs2	2	54.67	46.21	−99.0	13.19	17.83	0.0	NaN

RDC

Genetic trends

Here, we exhibit the genetic trends of our evaluations for each trait. We see that the levels of breeding values are generally in agreement across evaluations.

Table 30: Genetic trends (Single-step (s) vs new EBV (newebv) vs official EBV (offebv)) for nordic AI bulls with at least 30 offspring in the full dataset

BYR	trait	n	m_ssm_newebv	m_offebv	s_ss	s_newebv	s_offebv	cor
2010	sb1	155	96.92	97.18	97.22	8.76	9.01	9.0	0.99
2011	sb1	156	98.87	98.99	98.85	8.65	9.04	8.81	0.99
2012	sb1	159	99.35	99.43	99.51	7.32	7.67	7.49	0.99
2013	sb1	110	99.31	99.47	99.23	8.05	8.34	8.18	0.99
2014	sb1	81	99.43	99.64	99.36	8.57	8.56	8.44	0.99
2015	sb1	68	101.01	100.93	100.63	6.42	6.6	6.43	0.99
2016	sb1	67	100.7	100.63	100.51	7.09	7.24	7.18	0.99
2017	sb1	66	100.33	100.24	100.13	6.62	6.69	6.54	0.98
2018	sb1	51	100.63	100.47	100.24	5.49	5.49	5.34	0.98
2019	sb1	45	101.44	101.16	100.81	8.74	9.0	8.91	0.99
2020	sb1	48	102.81	102.19	101.84	7.4	7.35	7.21	0.99
2021	sb1	38	102.26	102.08	101.94	6.17	6.2	6.08	0.99
2022	sb1	33	103.12	102.64	102.56	7.68	7.92	7.79	0.99
2010	ce1	155	98.37	98.73	98.69	10.01	9.9	9.94	0.99
2011	ce1	156	100.09	100.37	100.2	10.42	10.62	10.64	0.99
2012	ce1	159	99.99	100.23	100.13	9.58	9.51	9.47	0.99
2013	ce1	110	99.52	99.77	99.58	9.34	9.45	9.49	0.99
2014	ce1	81	99.57	99.68	99.47	10.3	10.25	10.27	0.99
2015	ce1	68	100.72	100.97	100.83	8.27	8.13	8.09	0.99
2016	ce1	67	101.75	101.55	101.35	8.08	8.16	8.08	0.99

BYR	trait	n	m_ssm	m_newebv	m_offebv	s_ss	s_newebv	s_offebv	cor
2017	ce1	66	100.94	100.77	100.69	8.66	8.82	8.82	0.99
2018	ce1	51	102.84	102.49	102.38	6.96	6.77	6.71	0.99
2019	ce1	45	102.09	101.82	101.67	8.7	8.56	8.68	1.0
2020	ce1	48	101.56	101.25	101.03	7.16	7.1	7.15	0.99
2021	ce1	38	103.13	102.76	102.77	6.18	6.05	6.02	0.99
2022	ce1	33	101.7	101.15	101.06	6.5	6.54	6.44	0.98
2010	cs1	155	102.74	102.09	101.9	9.81	9.65	9.67	0.98
2011	cs1	156	98.64	98.29	98.26	10.25	10.06	10.01	0.98
2012	cs1	159	99.01	98.64	98.62	10.11	9.82	9.8	0.98
2013	cs1	110	100.76	100.53	100.55	9.83	9.51	9.5	0.98
2014	cs1	81	100.22	100.42	100.51	11.66	11.51	11.51	0.99
2015	cs1	68	98.35	97.88	98.05	9.33	9.08	9.03	0.99
2016	cs1	67	98.09	98.42	98.49	9.4	9.55	9.54	0.99
2017	cs1	66	99.52	99.68	99.72	9.78	9.74	9.66	0.99
2018	cs1	51	97.78	97.92	97.97	9.75	9.75	9.81	0.99
2019	cs1	45	98.84	99.0	99.18	9.63	9.62	9.63	0.99
2020	cs1	48	98.31	98.29	98.39	11.1	11.04	11.01	1.0
2021	cs1	38	98.45	99.03	99.05	9.73	9.75	9.7	0.99
2022	cs1	33	97.0	97.94	98.03	6.83	6.75	6.73	0.95
2010	sb2	155	95.94	96.38	95.92	8.33	8.48	8.5	0.98
2011	sb2	156	99.77	100.19	99.68	8.47	8.96	8.82	0.98
2012	sb2	159	99.13	99.42	99.1	7.65	7.82	7.7	0.98
2013	sb2	110	98.39	98.74	98.27	9.35	9.73	9.67	0.99
2014	sb2	81	99.47	99.77	99.26	6.9	7.03	7.02	0.99
2015	sb2	68	99.6	99.81	99.29	7.63	7.67	7.65	0.99
2016	sb2	67	100.22	100.18	99.96	7.54	7.72	7.69	0.99
2017	sb2	66	100.5	100.35	100.13	6.94	6.84	6.71	0.98
2018	sb2	51	101.33	100.96	100.79	5.23	5.07	5.05	0.98
2019	sb2	45	100.93	100.27	99.79	7.53	7.59	7.56	0.99
2020	sb2	48	102.5	102.27	101.9	6.5	6.25	6.16	0.99
2021	sb2	38	101.92	101.18	101.09	5.99	6.1	5.98	0.98
2022	sb2	33	103.76	103.21	103.23	6.64	6.74	6.61	0.98
2010	ce2	155	97.91	98.14	97.78	10.19	10.27	10.35	0.99

BYR	trait	n	m_ssm_newebv	m_offebv	s_ss	s_newebv	s_offebv	cor
2011	ce2	156	100.76	101.07	100.74	9.92	10.18	10.26	0.99
2012	ce2	159	99.99	100.06	99.79	9.31	9.61	9.66	0.99
2013	ce2	110	98.96	99.0	98.62	10.61	10.66	10.79	0.99
2014	ce2	81	99.37	99.33	98.9	8.88	9.06	9.13	0.99
2015	ce2	68	100.81	100.82	100.61	8.09	8.02	8.05	0.99
2016	ce2	67	101.09	100.73	100.48	7.57	7.81	7.8	0.99
2017	ce2	66	101.64	101.41	101.19	7.97	8.11	8.19	0.99
2018	ce2	51	102.55	102.27	102.08	6.87	6.81	6.85	0.99
2019	ce2	45	101.96	101.82	101.63	7.34	7.23	7.32	0.99
2020	ce2	48	101.52	101.19	101.09	7.18	7.21	7.17	0.99
2021	ce2	38	102.5	102.24	102.25	5.64	5.56	5.7	0.99
2022	ce2	33	102.33	101.64	101.65	5.39	4.99	5.05	0.95
2010	cs2	155	104.2	103.37	102.92	9.95	9.68	9.69	0.97
2011	cs2	156	99.27	98.94	98.67	10.89	10.67	10.61	0.98
2012	cs2	159	100.27	99.7	99.41	10.43	10.11	10.11	0.97
2013	cs2	110	101.12	100.86	100.73	10.28	9.99	9.98	0.98
2014	cs2	81	100.73	101.04	100.94	10.71	10.86	10.86	0.99
2015	cs2	68	99.44	99.06	99.06	9.2	9.15	9.09	0.98
2016	cs2	67	98.51	98.61	98.62	10.62	10.74	10.7	0.99
2017	cs2	66	99.7	99.97	99.99	10.43	10.4	10.33	0.99
2018	cs2	51	97.16	97.47	97.48	9.68	9.59	9.55	0.99
2019	cs2	45	98.29	99.0	99.13	10.23	10.46	10.42	0.99
2020	cs2	48	97.06	97.38	97.45	11.28	11.18	11.18	0.99
2021	cs2	38	96.18	96.92	96.93	9.96	10.14	10.09	0.99
2022	cs2	33	95.91	96.61	96.78	7.76	7.59	7.5	0.96

Table 31: Genetic trends (Single-step full dataset (f) vs single-step reduced dataset (r)) for nordic AI bulls with at least 30 offspring in the full dataset

BYR	trait	n	m_f	m_r	s_f	s_r	m_diff	cor
2010	sb1	155	97.68	97.72	8.58	8.71	0.34	1.0
2011	sb1	156	99.55	99.53	8.44	8.61	0.3	1.0
2012	sb1	159	100.04	100.1	7.15	7.18	0.38	1.0
2013	sb1	110	99.98	100.13	7.85	7.96	0.44	1.0
2014	sb1	81	100.01	100.27	8.32	8.36	0.6	0.99

BYR	trait	n	m_f	m_r	s_f	s_r	m_diff	cor
2015	sb1	68	101.71	101.53	6.32	6.27	0.85	0.98
2016	sb1	67	101.48	101.91	6.97	7.08	0.97	0.98
2017	sb1	66	100.94	101.29	6.5	6.45	1.56	0.95
2018	sb1	51	101.35	101.59	5.32	5.27	3.8	0.61
2019	sb1	45	102.13	103.16	8.5	4.12	5.6	0.5
2020	sb1	48	103.33	103.67	7.3	4.79	5.0	0.56
2021	sb1	38	102.92	102.53	6.03	3.5	3.87	0.55
2022	sb1	33	103.76	102.79	7.36	3.25	5.64	0.32
2023	sb1	2	107.0	104.0	1.41	2.83	3.0	1.0
2010	ce1	155	98.69	98.63	9.95	10.0	0.3	1.0
2011	ce1	156	100.35	100.33	10.4	10.35	0.22	1.0
2012	ce1	159	100.25	100.26	9.5	9.48	0.43	1.0
2013	ce1	110	99.77	99.75	9.38	9.49	0.38	1.0
2014	ce1	81	99.89	99.79	10.24	10.19	0.42	1.0
2015	ce1	68	100.99	100.9	8.21	8.13	0.62	0.99
2016	ce1	67	102.0	102.03	7.99	8.19	0.72	0.99
2017	ce1	66	101.17	101.88	8.66	8.49	1.35	0.98
2018	ce1	51	103.02	102.0	6.91	6.02	4.35	0.69
2019	ce1	45	102.38	102.93	8.61	5.7	5.36	0.55
2020	ce1	48	101.77	101.25	7.16	5.84	5.06	0.54
2021	ce1	38	103.37	102.39	6.3	5.79	3.61	0.67
2022	ce1	33	102.0	101.48	6.48	3.67	4.94	0.3
2023	ce1	2	105.5	101.0	2.12	5.66	4.5	1.0
2010	cs1	155	102.52	102.48	9.79	9.81	0.61	1.0
2011	cs1	156	98.43	98.39	10.25	10.11	0.59	1.0
2012	cs1	159	98.81	98.84	10.07	9.97	0.62	1.0
2013	cs1	110	100.48	100.47	9.76	9.75	0.68	0.99
2014	cs1	81	100.09	100.12	11.6	11.56	0.65	1.0
2015	cs1	68	98.04	98.26	9.34	9.31	0.81	0.99
2016	cs1	67	97.91	97.84	9.43	9.13	1.27	0.98
2017	cs1	66	99.36	98.73	9.81	9.46	1.88	0.97
2018	cs1	51	97.61	99.22	9.79	6.49	5.45	0.71
2019	cs1	45	98.62	98.93	9.72	5.76	6.04	0.57

BYR	trait	n	m_f	m_r	s_f	s_r	m_diff	cor
2020	cs1	48	98.04	99.75	11.06	6.3	7.08	0.66
2021	cs1	38	98.34	99.84	9.63	5.13	5.92	0.57
2022	cs1	33	96.91	99.09	6.84	3.82	6.0	0.09
2023	cs1	2	93.5	101.5	3.54	4.95	8.0	1.0
2010	sb2	155	96.63	96.54	8.21	8.25	0.43	1.0
2011	sb2	156	100.42	100.39	8.33	8.5	0.42	1.0
2012	sb2	159	99.77	99.79	7.47	7.51	0.5	0.99
2013	sb2	110	99.08	99.14	9.18	9.17	0.67	0.99
2014	sb2	81	100.06	100.19	6.85	6.82	0.64	0.99
2015	sb2	68	100.18	100.19	7.46	7.66	0.87	0.99
2016	sb2	67	100.85	101.03	7.4	7.47	0.87	0.99
2017	sb2	66	101.14	101.15	6.79	6.9	1.23	0.97
2018	sb2	51	101.84	101.59	5.08	4.58	3.39	0.6
2019	sb2	45	101.58	102.91	7.42	4.13	4.76	0.55
2020	sb2	48	102.96	102.73	6.35	4.8	4.31	0.59
2021	sb2	38	102.55	102.53	5.83	3.45	3.82	0.41
2022	sb2	33	104.39	101.64	6.51	3.71	5.55	0.3
2023	sb2	2	103.5	102.5	2.12	4.95	2.0	1.0
2010	ce2	155	98.11	98.19	10.28	10.24	0.36	1.0
2011	ce2	156	101.02	101.11	10.0	10.02	0.35	1.0
2012	ce2	159	100.23	100.21	9.44	9.5	0.45	1.0
2013	ce2	110	99.15	99.25	10.65	10.71	0.45	1.0
2014	ce2	81	99.58	99.53	8.87	8.96	0.49	1.0
2015	ce2	68	101.0	100.93	8.05	8.08	0.66	0.99
2016	ce2	67	101.33	101.25	7.57	7.54	0.79	0.99
2017	ce2	66	101.83	102.0	8.09	8.43	1.05	0.99
2018	ce2	51	102.8	101.71	6.9	5.66	4.08	0.68
2019	ce2	45	102.24	101.96	7.48	5.13	5.62	0.36
2020	ce2	48	101.73	100.94	7.25	5.82	5.0	0.61
2021	ce2	38	102.68	101.5	5.7	5.29	4.13	0.57
2022	ce2	33	102.58	100.94	5.46	3.56	4.42	0.33
2023	ce2	2	104.0	98.5	7.07	6.36	5.5	1.0
2010	cs2	155	103.72	103.67	9.95	9.96	0.65	1.0

BYR	trait	n	m_f	m_r	s_f	s_r	m_diff	cor
2011	cs2	156	98.72	98.65	10.83	11.0	0.66	1.0
2012	cs2	159	99.79	99.79	10.42	10.53	0.65	1.0
2013	cs2	110	100.6	100.69	10.26	10.41	0.76	0.99
2014	cs2	81	100.26	100.31	10.63	10.71	0.72	1.0
2015	cs2	68	98.9	98.97	9.28	9.36	1.1	0.99
2016	cs2	67	97.91	97.63	10.62	10.61	1.21	0.99
2017	cs2	66	99.23	97.97	10.41	10.02	1.83	0.98
2018	cs2	51	96.59	98.98	9.82	6.87	5.88	0.65
2019	cs2	45	97.82	97.31	10.15	6.43	6.29	0.61
2020	cs2	48	96.69	98.54	11.15	6.39	7.56	0.59
2021	cs2	38	95.71	98.21	10.03	5.36	6.24	0.52
2022	cs2	33	95.36	97.91	7.74	3.83	6.24	0.25
2023	cs2	2	89.5	97.0	3.54	7.07	7.5	1.0

Table 32: Genetic trends (Single-step full dataset (f) vs single-step reduced dataset (r)) for nordic cows with genotype and phenotype

BYR	trait	n	m_f	m_r	s_f	s_r	m_diff	cor
2010	sb1	3730	97.05	97.03	4.92	4.9	0.74	0.98
2011	sb1	6525	97.41	97.41	4.88	4.9	0.73	0.98
2012	sb1	7355	97.76	97.78	4.9	4.95	0.74	0.98
2013	sb1	7811	98.23	98.28	4.71	4.74	0.74	0.98
2014	sb1	8725	98.57	98.63	4.66	4.66	0.76	0.98
2015	sb1	11429	99.68	99.73	4.86	4.85	0.74	0.98
2016	sb1	15758	99.59	99.72	4.91	4.91	0.77	0.98
2017	sb1	18828	100.04	100.09	4.66	4.64	0.79	0.97
2018	sb1	21218	100.72	100.81	4.47	4.53	0.83	0.97
2019	sb1	21595	100.57	100.75	4.68	4.68	0.87	0.97
2020	sb1	23892	101.31	101.11	4.35	4.49	1.29	0.92
2021	sb1	24213	100.43	100.54	4.49	4.21	2.05	0.81
2022	sb1	25214	100.44	101.29	5.2	4.08	2.73	0.69
2023	sb1	23340	101.02	101.8	4.33	4.02	2.4	0.74
2024	sb1	23615	101.43	102.09	4.46	3.74	2.37	0.73
2025	sb1	7140	101.88	101.9	4.58	3.56	2.66	0.66
2010	ce1	3730	97.35	97.31	6.12	6.06	0.74	0.99

BYR	trait	n	m_f	m_r	s_f	s_r	m_diff	cor
2011	ce1	6525	97.84	97.84	5.95	5.9	0.74	0.99
2012	ce1	7355	98.07	98.07	6.12	6.12	0.75	0.99
2013	ce1	7811	97.78	97.78	6.24	6.19	0.76	0.99
2014	ce1	8725	98.06	98.09	6.15	6.1	0.76	0.99
2015	ce1	11429	98.71	98.72	6.38	6.35	0.76	0.99
2016	ce1	15758	98.4	98.42	6.41	6.35	0.78	0.99
2017	ce1	18828	98.6	98.59	6.22	6.21	0.79	0.99
2018	ce1	21218	99.62	99.58	6.34	6.38	0.81	0.98
2019	ce1	21595	100.2	100.29	5.74	5.74	0.85	0.98
2020	ce1	23892	99.93	99.46	6.13	6.2	1.71	0.92
2021	ce1	24213	100.52	100.13	5.51	5.59	2.31	0.85
2022	ce1	25214	99.75	100.21	5.92	5.07	2.84	0.75
2023	ce1	23340	100.47	100.23	5.2	4.87	2.54	0.78
2024	ce1	23615	101.39	100.86	4.95	4.57	2.47	0.78
2025	ce1	7140	101.18	100.48	4.8	4.26	2.65	0.73
2010	cs1	3730	102.25	102.21	6.13	6.03	0.94	0.98
2011	cs1	6525	101.6	101.54	6.25	6.13	0.93	0.98
2012	cs1	7355	101.02	100.94	6.8	6.7	0.92	0.98
2013	cs1	7811	101.36	101.33	6.38	6.27	0.96	0.98
2014	cs1	8725	101.3	101.26	6.78	6.68	0.95	0.98
2015	cs1	11429	100.52	100.52	6.72	6.62	0.96	0.98
2016	cs1	15758	101.28	101.31	7.1	6.96	0.98	0.98
2017	cs1	18828	100.69	100.77	6.67	6.53	0.99	0.98
2018	cs1	21218	100.3	100.4	6.43	6.24	1.07	0.98
2019	cs1	21595	100.05	100.06	6.56	6.46	1.13	0.97
2020	cs1	23892	99.91	100.89	7.04	6.25	2.32	0.89
2021	cs1	24213	99.94	101.01	6.72	5.34	3.04	0.84
2022	cs1	25214	100.57	100.28	6.5	5.0	3.58	0.73
2023	cs1	23340	100.29	100.53	5.94	4.67	3.31	0.73
2024	cs1	23615	99.14	99.61	5.68	4.39	3.16	0.71
2025	cs1	7140	98.65	99.87	5.43	4.25	3.62	0.62
2010	sb2	3730	96.86	96.92	5.07	5.03	0.67	0.98
2011	sb2	6525	97.38	97.44	5.15	5.13	0.65	0.98

BYR	trait	n	m_f	m_r	s_f	s_r	m_diff	cor
2012	sb2	7355	97.74	97.85	5.22	5.2	0.65	0.98
2013	sb2	7811	98.09	98.19	5.28	5.29	0.66	0.98
2014	sb2	8725	98.8	98.9	5.19	5.2	0.68	0.98
2015	sb2	11429	99.4	99.52	5.1	5.1	0.69	0.98
2016	sb2	15758	99.58	99.68	5.07	5.04	0.7	0.98
2017	sb2	18828	99.76	99.84	5.0	4.99	0.73	0.98
2018	sb2	21218	100.25	100.31	4.74	4.7	0.74	0.98
2019	sb2	21595	100.19	100.24	4.57	4.5	0.79	0.97
2020	sb2	23892	100.89	100.69	4.57	4.56	1.16	0.93
2021	sb2	24213	100.69	100.62	4.11	4.0	1.7	0.84
2022	sb2	25214	100.45	101.12	4.47	3.75	1.99	0.8
2023	sb2	23340	101.08	101.43	4.21	3.77	1.92	0.79
2024	sb2	23615	101.69	101.8	4.34	3.48	2.47	0.63
2025	sb2	7140	102.26	101.28	4.23	3.44	2.78	0.61
2010	ce2	3730	97.43	97.58	5.99	5.91	0.72	0.99
2011	ce2	6525	97.91	98.05	5.78	5.75	0.71	0.99
2012	ce2	7355	98.12	98.27	6.22	6.22	0.71	0.99
2013	ce2	7811	98.09	98.23	6.41	6.41	0.71	0.99
2014	ce2	8725	98.32	98.47	5.99	5.99	0.74	0.99
2015	ce2	11429	98.66	98.74	6.33	6.33	0.72	0.99
2016	ce2	15758	98.5	98.55	6.08	6.06	0.74	0.99
2017	ce2	18828	98.86	98.86	5.78	5.76	0.74	0.98
2018	ce2	21218	99.34	99.31	5.81	5.75	0.77	0.98
2019	ce2	21595	99.98	100.01	5.48	5.45	0.8	0.98
2020	ce2	23892	100.12	99.57	6.13	6.07	1.57	0.93
2021	ce2	24213	100.68	99.87	5.09	4.96	2.22	0.84
2022	ce2	25214	100.03	100.22	5.37	4.67	2.71	0.74
2023	ce2	23340	100.78	100.23	4.81	4.52	2.39	0.8
2024	ce2	23615	101.29	100.77	4.46	4.28	2.3	0.78
2025	ce2	7140	101.12	100.33	4.36	3.96	2.49	0.73
2010	cs2	3730	103.01	102.9	6.4	6.29	0.99	0.98
2011	cs2	6525	102.12	101.98	6.54	6.49	0.99	0.98
2012	cs2	7355	101.87	101.71	7.02	6.99	0.99	0.98

BYR	trait	n	m_f	m_r	s_f	s_r	m_diff	cor
2013	cs2	7811	102.26	102.14	7.03	6.99	1.0	0.98
2014	cs2	8725	101.92	101.79	7.35	7.33	1.0	0.98
2015	cs2	11429	101.07	101.02	7.25	7.26	1.04	0.98
2016	cs2	15758	101.26	101.26	7.27	7.2	1.06	0.98
2017	cs2	18828	101.15	101.15	6.74	6.7	1.08	0.98
2018	cs2	21218	100.19	100.22	6.86	6.8	1.12	0.98
2019	cs2	21595	100.35	99.99	7.12	7.05	1.19	0.98
2020	cs2	23892	99.04	99.87	7.2	6.36	2.64	0.86
2021	cs2	24213	99.58	100.1	7.22	5.89	3.4	0.81
2022	cs2	25214	100.11	99.49	6.92	5.38	4.0	0.71
2023	cs2	23340	99.31	99.67	6.17	5.01	3.37	0.73
2024	cs2	23615	98.03	98.84	6.16	4.65	3.47	0.69
2025	cs2	7140	97.75	99.04	5.81	4.39	3.83	0.6

Test of Foreign information

As part of the Interbull collaboration, we recieve breeding values from foreign (non-nordic) bulls, along with a reliability. These has to be converted to a pseudo-phenotype to be included in the evaluation. Here, we test that the calculated breeding values for these bulls are similar to the original ones from Interbull in mean and standard deviation.

Table 33: Means and standard deviations for foreign bulls in single-step (ss), new EBV (ebv) and original interbull breeding value (bv), as well as correlation between single-step breeding value and Interbull breeding value. Calving ease first lactation.

BYR	n	m_ss	m_ebv	m_bv	s_ss	s_ebv	s_bv	cor_ss	cor_ebv
2009	127	98.59	98.8	99.62	9.27	9.42	9.78	0.96	0.97
2010	106	97.39	97.79	98.33	11.11	11.34	11.31	0.93	0.92
2011	117	98.74	98.92	99.63	10.7	10.46	10.3	0.95	0.94
2012	117	95.89	96.25	97.4	10.89	11.29	10.71	0.95	0.97
2013	85	98.01	98.2	99.19	9.53	9.91	9.5	0.95	0.97
2014	14	95.0	95.0	95.05	10.46	10.74	9.44	0.97	0.97
2015	16	93.81	93.75	96.1	12.12	11.13	11.55	0.97	0.98
2016	34	99.41	99.56	101.01	9.35	8.83	9.45	0.96	0.97
2017	16	97.81	98.5	101.45	10.87	11.26	9.35	0.97	0.98
2018	26	96.73	96.0	98.83	8.83	8.69	8.63	0.91	0.91
2019	47	97.79	97.85	99.64	9.14	8.99	9.38	0.93	0.97
2020	29	98.38	98.34	102.87	9.61	9.39	9.99	0.94	0.96

BYR	n	m_ss	m_ebv	m_bv	s_ss	s_ebv	s_bv	cor_ss	cor_ebv
2021	44	96.39	96.14	100.3	10.3	9.51	10.57	0.97	0.98
2022	20	97.75	98.65	101.47	8.46	9.19	9.65	0.95	0.95

Correlations

Here, we give correlation tables and tables of differences between the relevant evaluations. We test that we didn't change the model by comparing our new model without genomic information to the breeding values of the traditional pedigree-based model and expect very high correlations for tested animals. We test the change by incorporating genomic information, compared to a non-genomic evaluation, and expect to see some changes even in tested animals, but not too large.

Table 34: Correlations between current EBV and new EBV for Nordic AI bulls with > 30 offspring

BYR	n	cor1	cor2	cor3	cor4	cor5	cor6
2009	151	0.995	0.999	0.997	0.996	0.999	0.998
2010	155	0.995	0.998	0.998	0.996	0.999	0.998
2011	156	0.997	0.999	0.999	0.996	0.999	0.999
2012	159	0.997	0.999	0.999	0.996	0.999	0.999
2013	110	0.997	0.999	0.999	0.998	0.999	0.999
2014	81	0.998	0.999	0.999	0.996	0.999	0.999
2015	68	0.998	0.999	0.999	0.998	0.999	0.999
2016	67	0.999	0.999	0.999	0.999	0.999	0.999
2017	66	0.998	0.999	0.999	0.998	0.999	0.999
2018	51	0.997	0.998	0.999	0.996	0.998	0.999
2019	45	0.999	0.999	0.999	0.999	0.999	1.0
2020	48	0.997	0.996	0.999	0.997	0.999	0.999
2021	38	0.997	0.998	0.999	0.997	0.998	0.999
2022	33	0.999	0.998	0.998	0.999	0.998	0.997

Table 35: Table of differences between current EBV and new EBV for Nordic AI bulls with > 30 offspring born after 2015

dif	dif1	dif2	dif3	dif4	dif5	dif6
−3.0	0	1	0	0	0	0
−2.0	4	1	0	2	0	0
−1.0	75	60	12	95	67	29
0.0	251	269	294	236	273	277
1.0	20	19	43	17	10	42

dif	dif1	dif2	dif3	dif4	dif5	dif6
2.0	0	0	1	0	0	2

Table 36: Correlations between current EBV and new Single-step for AI bulls with > 30 offspring

BYR	n	cor1	cor2	cor3	cor4	cor5	cor6
2009	151	0.988	0.985	0.972	0.982	0.991	0.972
2010	155	0.987	0.991	0.978	0.98	0.99	0.972
2011	156	0.988	0.99	0.982	0.984	0.993	0.982
2012	159	0.986	0.988	0.977	0.982	0.988	0.973
2013	110	0.992	0.99	0.977	0.99	0.992	0.982
2014	81	0.994	0.994	0.991	0.987	0.995	0.988
2015	68	0.987	0.99	0.988	0.992	0.993	0.985
2016	67	0.993	0.994	0.986	0.99	0.988	0.991
2017	66	0.985	0.992	0.988	0.981	0.991	0.99
2018	51	0.976	0.987	0.991	0.978	0.991	0.989
2019	45	0.994	0.996	0.994	0.986	0.989	0.991
2020	48	0.994	0.987	0.995	0.99	0.988	0.991
2021	38	0.99	0.987	0.992	0.981	0.986	0.991
2022	33	0.991	0.978	0.952	0.98	0.954	0.964

Table 37: Table of differences between current EBV and new Single-step for AI bulls with > 30 offspring born after 2015

dif	dif1	dif2	dif3	dif4	dif5	dif6
−6.0	0	0	1	0	0	1
−5.0	1	0	0	2	2	0
−4.0	0	5	2	4	4	2
−3.0	7	10	10	18	12	11
−2.0	37	31	14	42	32	11
−1.0	113	101	45	105	104	38
0.0	143	154	131	125	144	132
1.0	37	35	85	41	42	102
2.0	9	12	35	10	4	20
3.0	3	2	17	2	6	19
4.0	0	0	7	1	0	7
5.0	0	0	3	0	0	4

dif	dif1	dif2	dif3	dif4	dif5	dif6
6.0	0	0	0	0	0	3

Table 38: Correlations between current two-step and new Single-step for genotyped AI bulls born after 2009 with > 30 offspring

BYR	n	cor
2010	155	0.959
2011	156	0.959
2012	159	0.962
2013	110	0.974
2014	81	0.975
2015	68	0.973
2016	66	0.968
2017	66	0.97
2018	51	0.958
2019	45	0.978
2020	48	0.986
2021	38	0.932
2022	33	0.834

Table 39: Table of differences between current two-step and new Single-step for genotyped AI bulls with > 30 offspring born after 2015

dif	dif13
−8.0	3
−7.0	1
−6.0	2
−5.0	6
−4.0	12
−3.0	17
−2.0	39
−1.0	78
0.0	96
1.0	54
2.0	19
3.0	7
4.0	5

dif	dif13
5.0	4
6.0	4
7.0	1
8.0	0
9.0	1

Table 40: Correlations between current two-step and new Single-step for genotyped nordic bulls with no offspring born after 2015

BYR	n	cor
2020	2767	0.695
2021	2731	0.692
2022	2532	0.734
2023	2296	0.656
2024	2205	0.689
2025	763	0.589

Table 41: Table of differences between current two-step and new Single-step for genotyped nordic bulls born after 2009 with no offspring

dif	dif13
−18.0	1
−17.0	0
−16.0	1
−15.0	1
−14.0	3
−13.0	12
−12.0	25
−11.0	50
−10.0	84
−9.0	108
−8.0	197
−7.0	279
−6.0	362
−5.0	540
−4.0	660
−3.0	783

dif	dif13
−2.0	992
−1.0	959
0.0	1027
1.0	1011
2.0	923
3.0	793
4.0	656
5.0	514
6.0	427
7.0	262
8.0	178
9.0	107
10.0	65
11.0	44
12.0	24
13.0	10
14.0	9
15.0	5
16.0	1
17.0	2
18.0	0
19.0	2

Legarra-Reverter test

The Legarra-Reverter test is a test for bias in evaluations. We perform two calculations of breeding values, one with all information available and one where offspring of sires born after 2018 has their records removed. Then we perform a linear regression on genotyped, nordic bulls, who has no data in the reduced dataset and with more than 30 offspring in the full dataset. We also require that their sires are not in the focal group, so we remove bulls whose father meets the same criteria.

The slope of the regression indicates the bias, with a slope of one meaning no bias, a slope less than one indicating that the estimated values of unproven animals are too extreme, and a slope higher than one indicating that the estimated breeding values of unproven animals are too conservative.

As can be seen, we have some issues with the Legarra-Reverter test. We're looking into it.

Table 42: Legarra-Reverter scores

Singlestep:

trait	b1	rsquare	n
nysb1	0.869	0.314	111
nyce1	0.869	0.443	111
nycs1	1.015	0.4	46
nysb2	0.879	0.358	116
nyce2	0.828	0.391	115
nycs2	0.992	0.376	66

EBV:

trait	b1	rsquare	n
nysb1	0.883	0.22	111
nyce1	0.778	0.271	111
nycs1	0.78	0.236	46
nysb2	0.877	0.218	116
nyce2	0.76	0.262	115
nycs2	0.909	0.29	66

Interbull test

An Interbull GEBV test was performed. We passed.

```
735 brd pop trt evaldate m ntest    mean_y     std_y dv    mean_x     std_x        b0     se_b0      b1   se_b1 ncand
i_est  Exp_b1   R2 fb year  tests  pass
735 RDC DFS sb1 20250904 1   100  102.4593    8.2662 GM  102.5400    4.8871   14.9086   15.4243  0.8529  0.1418   100
0.0000  1.0000 24.8  N 2015   YYN-  PASS
735 RDC DFS sb1 20250904 2   100  102.4593    8.2662 GM  101.5979    4.2719    9.4379   17.6878  0.9146  0.1738   100
0.0000  1.0000 22.0  N 2015   ----  ----
735 RDC DFS ce1 20250904 1    94  102.7014    8.6291 GM  102.6288    5.6829    3.3570   12.8732  0.9671  0.1091    94
0.0000  1.0000 39.2  N 2015   YYY-  PASS
735 RDC DFS ce1 20250904 2    94  102.7014    8.6291 GM  101.3299    4.9912    3.3951   15.3457  0.9783  0.1514    94
0.0000  1.0000 31.2  N 2015   ----  ----
735 RDC DFS cs1 20250904 1    79   98.2715   10.1719 GM   99.0576    5.8828   -8.1624   15.0292  1.0757  0.1450    79
0.0000  1.0000 39.6  N 2015   YYYY  PASS
735 RDC DFS cs1 20250904 2    79   98.2715   10.1719 GM   99.8267    5.7707   12.3880   17.4078  0.8624  0.1740    79
0.0000  1.0000 24.2  N 2015   ----  ----
735 RDC DFS sb2 20250904 1    98  102.2217    7.8311 GM  101.9402    4.5613    7.1889   14.9191  0.9311  0.1518    98
0.0000  1.0000 29.7  N 2015   YYY-  PASS
735 RDC DFS sb2 20250904 2    98  102.2217    7.8311 GM  100.8810    3.6876   -1.1560   18.7536  1.0237  0.1858    98
0.0000  1.0000 24.0  N 2015   ----  ----
735 RDC DFS ce2 20250904 1   101  102.7010    8.7446 GM  101.9315    5.4731   18.0644   14.1931  0.8301  0.1387   101
0.0000  1.0000 26.4  N 2015   YYN-  PASS
735 RDC DFS ce2 20250904 2   101  102.7010    8.7446 GM  100.9548    4.8127   19.9422   16.6803  0.8195  0.1652   101
0.0000  1.0000 19.9  N 2015   ----  ----
735 RDC DFS cs2 20250904 1    84   97.8271   10.2178 GM   98.1963    6.3490    7.5345   14.2576  0.9217  0.1523    84
0.0000  1.0000 33.1  N 2015   YYY-  PASS
735 RDC DFS cs2 20250904 2    84   97.8271   10.2178 GM   98.9962    6.0171   14.6332   16.0538  0.8431  0.1618    84
0.0000  1.0000 24.9  N 2015   ----  ----
```

The set of bulls chosen by the Interbull test program is different from the focal group selected for the Legarra-Reverter test. Hence, we get different slope coefficients.

Mendelian sampling

The mendelian sampling of an animals is its deviation of its breeding values from the expected breeding value, which is the average of its parents breeding values. Some mendelian samling is expected on the individual level (this is what enables breeding), but across all animals we expect it to be close to zero. Otherwise, this indicates a bias in the set of animals in the evaluation, which violates the unbiasedness of the BLUP model. We conclude that the mendelian sampling is generally close to 0.

Table 43: Average mendelian sampling by birth year. Animals are only included if they are genotyped, their sire has > 30 offspring and their dam is genotyped.

BYR	m1	m2	m3	m4	m5	m6
2010	0.108	−0.359	−0.069	0.375	−0.008	0.058
2011	0.033	−0.288	0.38	0.077	−0.283	0.503
2012	0.007	−0.279	0.255	−0.066	−0.199	0.138
2013	0.113	0.123	−0.186	0.283	0.255	−0.383
2014	−0.073	−0.11	−0.068	0.094	0.079	−0.351
2015	−0.086	−0.092	0.073	−0.047	−0.07	−0.069
2016	0.027	−0.008	−0.054	0.014	0.03	−0.088
2017	0.057	0.025	−0.053	0.064	0.041	−0.067
2018	−0.0	−0.01	−0.017	−0.017	0.022	−0.021
2019	0.054	0.042	−0.086	−0.003	0.074	−0.063
2020	0.017	0.055	−0.063	−0.045	0.028	−0.046
2021	0.019	−0.017	−0.082	0.016	0.003	−0.048
2022	0.028	−0.046	−0.026	0.067	0.029	−0.022
2023	0.011	−0.048	0.02	0.045	0.051	−0.02
2024	0.056	0.066	−0.054	0.009	0.049	−0.06

Table 44: Average mendelian sampling by birth year. Animals are only included if they are not genotyped, their sire has > 30 offspring and their dam isn't genotyped.

BYR	m1	m2	m3	m4	m5	m6
2001	0.011	−0.003	0.019	0.05	0.015	−0.024
2002	0.008	−0.003	−0.003	0.032	0.003	−0.028
2003	−0.002	0.011	−0.016	0.018	0.026	−0.011
2004	−0.004	0.004	−0.037	0.006	0.025	−0.01
2005	0.001	−0.002	−0.035	0.014	0.024	−0.021
2006	−0.011	0.019	−0.008	0.015	0.028	−0.019
2007	−0.006	−0.002	−0.009	0.028	0.027	−0.013
2008	0.012	−0.003	−0.006	0.012	0.018	−0.007

BYR	m1	m2	m3	m4	m5	m6
2009	−0.012	−0.023	0.016	−0.01	−0.004	−0.01
2010	0.002	−0.02	0.002	0.007	−0.013	−0.004
2011	0.023	−0.009	−0.015	0.041	−0.004	0.005
2012	0.002	−0.022	0.009	0.037	−0.001	0.0
2013	0.007	0.0	−0.001	0.013	0.008	0.003
2014	−0.014	−0.012	0.012	0.001	−0.009	−0.015
2015	−0.016	0.008	0.022	0.001	0.002	−0.025
2016	−0.007	−0.011	0.009	−0.013	0.002	−0.001
2017	−0.005	0.0	0.004	−0.001	−0.013	0.004
2018	−0.026	−0.011	0.029	−0.016	−0.026	0.033
2019	−0.001	−0.014	−0.005	−0.048	−0.029	0.034
2020	−0.008	0.004	0.013	−0.056	−0.031	0.052
2021	−0.013	−0.009	−0.035	0.0	−0.026	0.005
2022	0.013	−0.017	−0.007	0.028	0.014	−0.006
2023	−0.001	−0.035	0.043	0.013	0.011	−0.004
2024	0.009	0.001	−0.003	−0.02	−0.011	0.004

Reliabilities

Table 45: Comparison of reliabilties between single-step and current official evaluation for nordic AI bulls with > 30 offspring

BYR	trait	n	rel_ss	rel_ebv	rel_cur	s_rel_ss	s_rel_ebv	s_rel_cur	cor
2010	sb1	155	79.16	72.78	78.18	5.56	7.99	6.66	0.928411
2011	sb1	156	80.33	74.78	80.3	6.44	9.29	7.88	0.941367
2012	sb1	159	80.23	74.29	79.63	7.2	10.11	8.52	0.946391
2013	sb1	110	81.69	76.65	81.61	8.77	11.8	9.72	0.975429
2014	sb1	81	84.9	81.13	85.46	8.35	11.13	9.16	0.975107
2015	sb1	68	86.81	83.35	87.05	7.57	10.31	8.66	0.974388
2016	sb1	67	85.45	81.83	86.38	8.02	10.7	8.66	0.969936
2017	sb1	66	84.83	80.44	84.98	9.02	12.61	10.46	0.979601
2018	sb1	51	84.73	80.6	85.6	8.58	11.76	9.36	0.967847
2019	sb1	45	86.05	82.62	87.7	7.78	10.51	7.76	0.973043
2020	sb1	48	83.02	78.23	86.75	8.47	12.13	9.76	0.907993
2021	sb1	38	75.9	63.64	84.57	6.26	7.57	11.0	0.850499
2022	sb1	33	71.33	57.42	79.3	9.01	9.07	13.39	0.938082

BYR	trait	n	rel_ss	rel_ebv	rel_cur	s_rel_ss	s_rel_ebv	s_rel_cur	cor
2023	sb1	2	68.3	51.66	71.4	1.35	2.99	0.85	1.0
2010	ce1	155	78.79	72.78	76.71	5.65	7.99	7.50	0.884703
2011	ce1	156	79.98	74.78	79.04	6.54	9.29	8.80	0.895854
2012	ce1	159	79.89	74.29	78.11	7.32	10.11	9.60	0.908115
2013	ce1	110	81.37	76.65	79.94	8.92	11.8	11.04	0.944179
2014	ce1	81	84.63	81.13	84.52	8.5	11.13	10.30	0.952808
2015	ce1	68	86.57	83.35	86.04	7.7	10.31	9.70	0.962776
2016	ce1	67	85.19	81.83	85.62	8.15	10.7	9.80	0.954648
2017	ce1	66	84.56	80.44	84.02	9.17	12.61	11.74	0.96682
2018	ce1	51	84.46	80.6	84.73	8.73	11.76	10.53	0.9414
2019	ce1	45	85.79	82.62	87.32	7.91	10.51	8.20	0.955304
2020	ce1	48	82.7	78.23	86.45	8.62	12.13	10.50	0.892336
2021	ce1	38	75.5	63.64	84.22	6.41	7.57	11.66	0.844053
2022	ce1	33	70.84	57.42	79.26	9.21	9.07	13.56	0.934465
2023	ce1	2	67.81	51.66	71.2	1.42	2.99	0.57	1.0
2010	cs1	155	77.34	72.78	−99.0	6.02	7.99	0.0	NaN
2011	cs1	156	78.59	74.78	−99.0	6.96	9.29	0.0	NaN
2012	cs1	159	78.51	74.29	−99.0	7.8	10.11	0.0	NaN
2013	cs1	110	80.07	76.65	−99.0	9.53	11.8	0.0	NaN
2014	cs1	81	83.53	81.13	−99.0	9.08	11.13	0.0	NaN
2015	cs1	68	85.62	83.35	−99.0	8.22	10.31	0.0	NaN
2016	cs1	67	84.17	81.83	−99.0	8.68	10.7	0.0	NaN
2017	cs1	66	83.47	80.44	−99.0	9.79	12.61	0.0	NaN
2018	cs1	51	83.35	80.6	−99.0	9.32	11.76	0.0	NaN
2019	cs1	45	84.76	82.62	−99.0	8.46	10.51	0.0	NaN
2020	cs1	48	81.46	78.23	−99.0	9.22	12.13	0.0	NaN
2021	cs1	38	73.91	63.64	−99.0	7.02	7.57	0.0	NaN
2022	cs1	33	68.9	57.42	−99.0	10.06	9.07	0.0	NaN
2023	cs1	2	65.83	51.66	−99.0	1.73	2.99	0.0	NaN
2010	sb2	155	79.69	72.78	73.05	5.42	7.99	7.36	0.931168
2011	sb2	156	80.84	74.78	75.32	6.28	9.29	8.66	0.962526
2012	sb2	159	80.74	74.29	75.05	7.02	10.11	9.26	0.960116
2013	sb2	110	82.17	76.65	77.52	8.55	11.8	10.58	0.974176

BYR	trait	n	rel_ss	rel_ebv	rel_cur	s_rel_ss	s_rel_ebv	s_rel_cur	cor
2014	sb2	81	85.3	81.13	81.63	8.14	11.13	10.08	0.980382
2015	sb2	68	87.16	83.35	83.06	7.37	10.31	9.66	0.974831
2016	sb2	67	85.83	81.83	81.67	7.83	10.7	9.98	0.968503
2017	sb2	66	85.23	80.44	80.45	8.79	12.61	11.80	0.977468
2018	sb2	51	85.14	80.6	81.74	8.36	11.76	10.26	0.979766
2019	sb2	45	86.43	82.62	82.3	7.57	10.51	9.48	0.9728
2020	sb2	48	83.47	78.23	81.2	8.25	12.13	11.42	0.884183
2021	sb2	38	76.48	63.64	79.39	6.04	7.57	12.0	0.787589
2022	sb2	33	72.04	57.42	72.9	8.71	9.07	14.46	0.914197
2023	sb2	2	69.04	51.66	61.45	1.24	2.99	1.77	−1.0
2010	ce2	155	79.41	72.78	72.48	5.49	7.99	7.86	0.898797
2011	ce2	156	80.58	74.78	75.56	6.36	9.29	8.68	0.931913
2012	ce2	159	80.48	74.29	75.42	7.11	10.11	9.58	0.944572
2013	ce2	110	81.92	76.65	77.7	8.66	11.8	11.26	0.956611
2014	ce2	81	85.09	81.13	82.47	8.25	11.13	10.64	0.966385
2015	ce2	68	86.98	83.35	83.8	7.47	10.31	10.06	0.965511
2016	ce2	67	85.63	81.83	82.85	7.93	10.7	10.38	0.953868
2017	ce2	66	85.02	80.44	81.75	8.91	12.61	11.90	0.965348
2018	ce2	51	84.93	80.6	83.44	8.48	11.76	10.02	0.967319
2019	ce2	45	86.23	82.62	83.75	7.68	10.51	9.37	0.963816
2020	ce2	48	83.24	78.23	82.94	8.37	12.13	11.36	0.877938
2021	ce2	38	76.18	63.64	81.37	6.15	7.57	12.20	0.817351
2022	ce2	33	71.67	57.42	74.06	8.86	9.07	14.90	0.923464
2023	ce2	2	68.66	51.66	64.05	1.3	2.99	0.64	−1.0
2010	cs2	155	77.45	72.78	−99.0	6.0	7.99	0.0	NaN
2011	cs2	156	78.7	74.78	−99.0	6.93	9.29	0.0	NaN
2012	cs2	159	78.62	74.29	−99.0	7.77	10.11	0.0	NaN
2013	cs2	110	80.17	76.65	−99.0	9.49	11.8	0.0	NaN
2014	cs2	81	83.62	81.13	−99.0	9.04	11.13	0.0	NaN
2015	cs2	68	85.69	83.35	−99.0	8.19	10.31	0.0	NaN
2016	cs2	67	84.24	81.83	−99.0	8.64	10.7	0.0	NaN
2017	cs2	66	83.55	80.44	−99.0	9.74	12.61	0.0	NaN
2018	cs2	51	83.44	80.6	−99.0	9.28	11.76	0.0	NaN

BYR	trait	n	rel_ss	rel_ebv	rel_cur	s_rel_ss	s_rel_ebv	s_rel_cur	cor
2019	cs2	45	84.84	82.62	−99.0	8.42	10.51	0.0	NaN
2020	cs2	48	81.55	78.23	−99.0	9.17	12.13	0.0	NaN
2021	cs2	38	74.04	63.64	−99.0	6.98	7.57	0.0	NaN
2022	cs2	33	69.05	57.42	−99.0	10.0	9.07	0.0	NaN
2023	cs2	2	65.98	51.66	−99.0	1.71	2.99	0.0	NaN

Table 46: Comparison of reliabilties between single-step and current official evaluation for nordic genotyped bulls with no offspring

BYR	n	ss_rel	two_rel	s_ss_rel	s_two_rel	cor
2020	2750	39.568	69.618	0.0	2.378	6.77023e-15
2021	2710	39.568	69.041	0.0	2.947	−3.95079e-14
2022	2511	39.568	68.726	0.0	2.563	−7.38285e-15
2023	2249	39.568	68.027	0.0	3.635	1.45597e-14
2024	2143	39.568	67.057	0.0	3.807	1.33919e-14
2025	762	39.568	64.795	0.0	3.815	−1.52763e-14