STØTTET AF
Mælkeafgiftsfonden

SingleStep (SS) analyses

By Kevin Byskov

Compare EBVs from the SS model with EBVs from the AUG20 routine evaluation.

Females

10,698,730 records were read from the cowEBVfull file with EBVs from the SS model (<u>without genomic data</u>) provided by Minna Koivula from LUKE, Finland. 10,550,214 records were read from the AUG20 routine phenotypic evaluation for yield traits.

10,548,955 records were found in both input datasets (99,99% of records in the AUG20 routine evaluation), while 1,259 records were available only from the AUG20 routine evaluation and 149,775 records were available only from the cowEBVfull file. Most of these extra animals are young genotyped animals from 2018-2020.

Results are not scaled in the same way, but it is expected that correlations between them are very high. However, there are slight differences between the two evaluations which might lead to minor differences. In the SS model inbreeding is considered in the A-matrix and also the pedigree and genetic groups are slightly different than in official AUG20 run.

In Figure 1 correlation between EBVs by birthyear and yield trait from the SS model and the AUG20 routine phenotypic evaluation can be seen. Only few correlations are below 0.99, and from 1995 to 2017 all correlations are 0.998 or higher. A table with all correlations can be found in

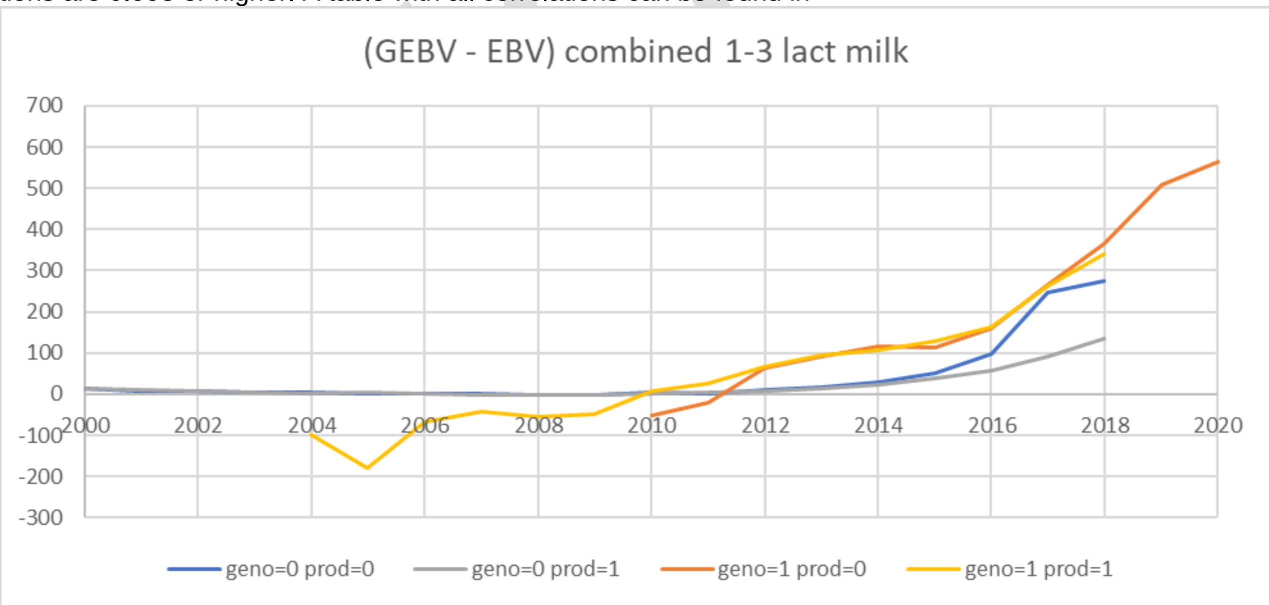


Figure 8 Difference between GEBV and EBV for the combined milk index calculated on groups of genotyped (geno=1) and non-genotyped (geno=0) females and females with (prod=1) and without (prod=0) production records in the full dataset.

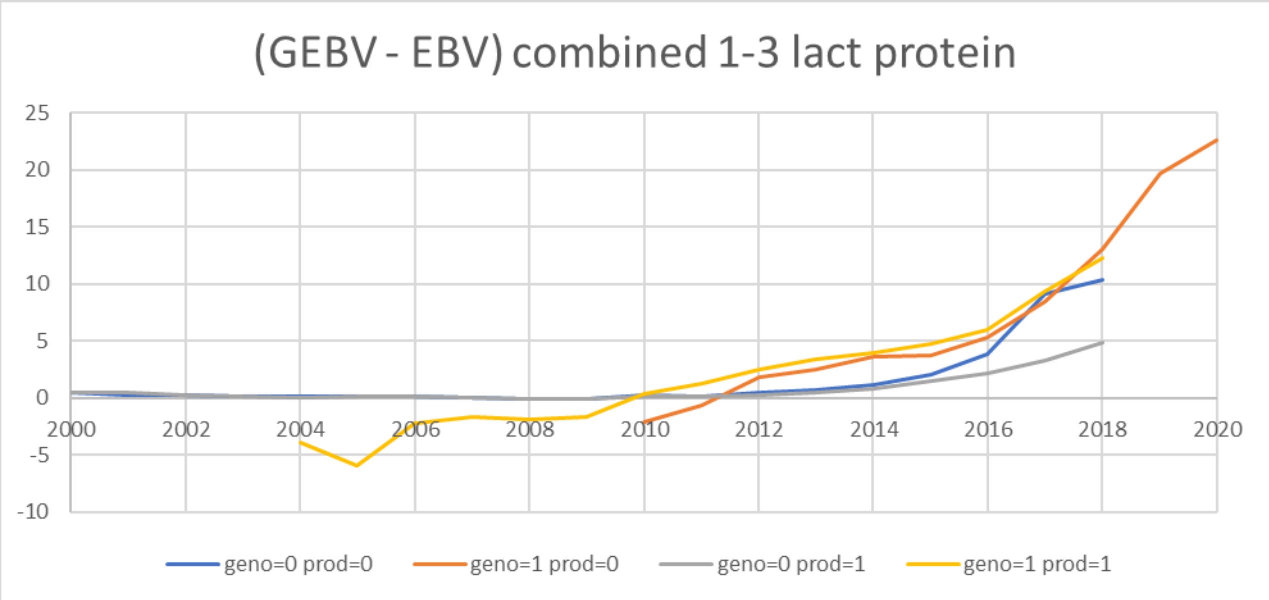


Figure 9 Difference between GEBV and EBV for the combined protein index calculated on groups of genotyped (geno=1) and non-genotyped (geno=0) females and females with (prod=1) and without (prod=0) production records in the full dataset.

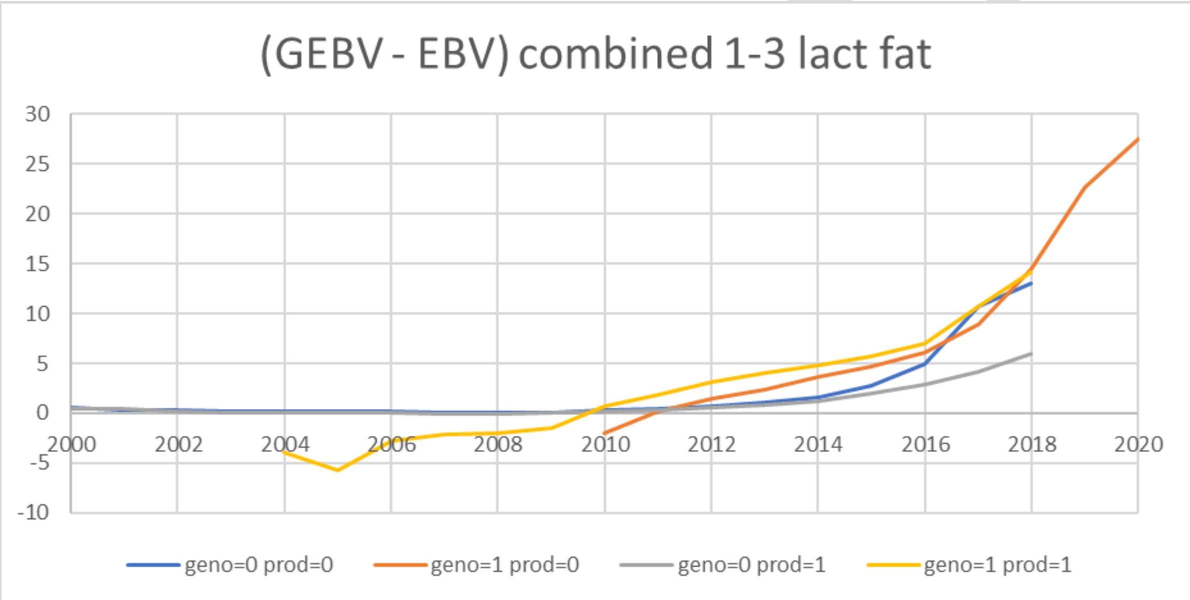


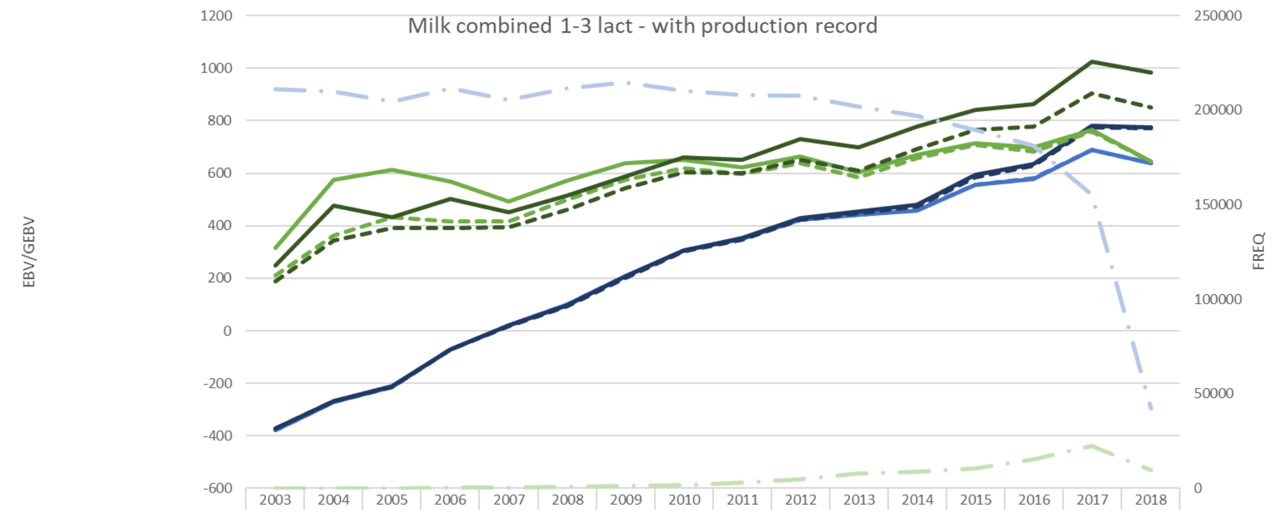
Figure 10 Difference between GEBV and EBV for the combined fat index calculated on groups of genotyped (geno=1) and non-genotyped (geno=0) females and females with (prod=1) and without (prod=0) production records in the full dataset.

The difference between non-genotyped and genotyped cows for (GEBV-EBV) is difficult to explain.

Pedigree index vs own index for EBV/GEBV

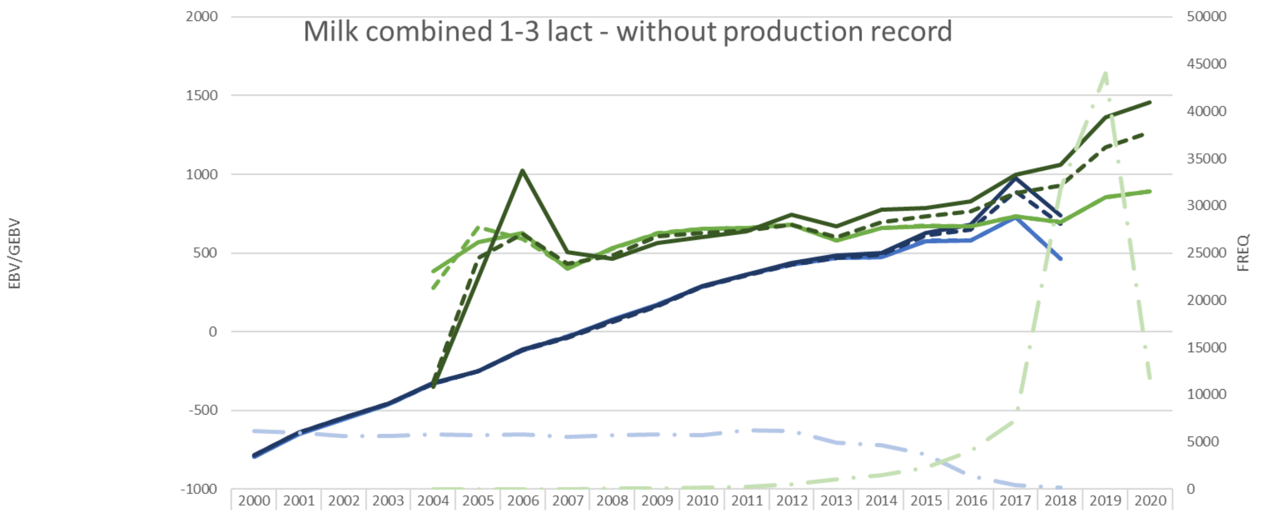
Earlier analysis indicated that production indices tend to increase when an animal get genomic tested. To test this, parent averages have been calculated for EBVs and GEBVs and compared with actual EBVs and GEBVs. As most females are genomic tested in a very young age, it is expected that average of the pedigree index would also be average of the actual EBVs/GEBVs as there has been no possibility to select animals on phenotypic data. The results can be seen in Figure 11 to Figure 16. Number of observations is only shown in Figure 11 and Figure 12, but number of observations in Figure 13 and Figure 15 is the same as in Figure 11 and similar the number of observations in Figure 14 and Figure 16 is the same as in Figure 12.

The figures show that no matter witch group of animals we look at, genotyped or non-genotyped and cows with own production records or females without production records, the EBVs and pedigree index based on EBVs are following each other nicely in the later year classes. For genotyped cows with own production records it is seen that in the period from 2003 until approx. 2013 the EBVs are higher than the EBV pedigree index, which indicate that these cows were selected on their index/own performance before they were genotyped. For non-genotyped cows with own performance records, the GEBV and pedigree index based on the GEBV is also following nicely in the whole period. For non-genotyped females without own performance records, the GEBV and pedigree index based on GEBV is also following each other nicely until 2016, where they start deviating a bit, so that the average GEBV for birth year classes 2017 and 2018 is slightly higher than average pedigree index based on GEBV. These two year classes are small and exists of females that have a genotyped offspring.



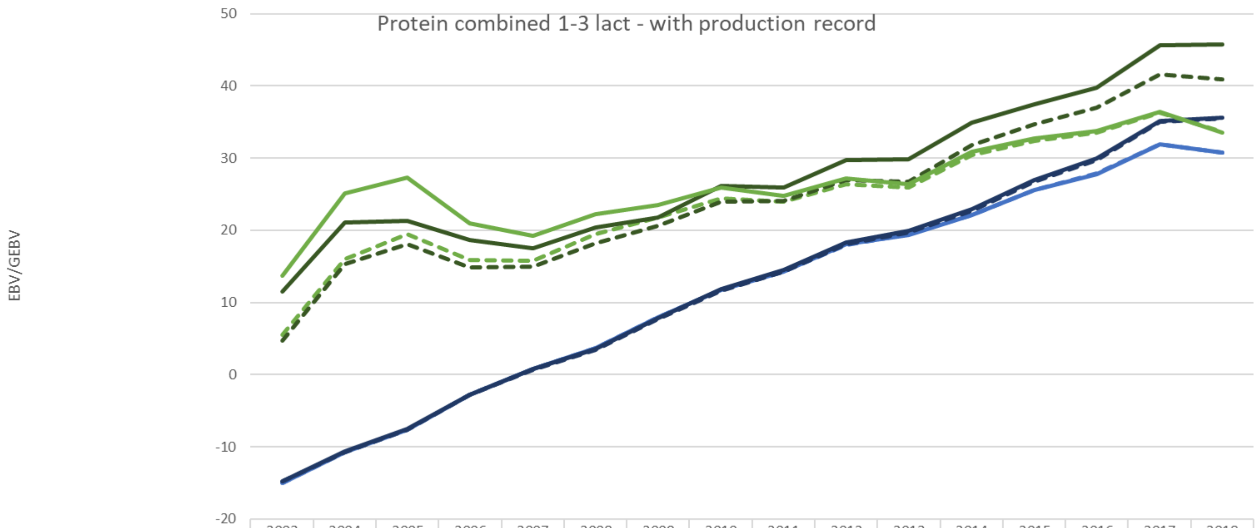
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
0 - Sum af EBVmilk	-378	-270	-215	-72	21	98	209	305	350	424	441	458	555	578	690	638
0 - Sum af EBVmilk_ped	-377	-270	-215	-70	20	99	209	304	352	424	443	461	556	581	690	638
0 - Sum af GEBVmilk	-374	-268	-212	-70	20	96	206	307	353	430	454	481	593	635	780	774
0 - Sum af GEBVmilk_ped	-373	-268	-214	-71	16	93	202	301	348	423	448	473	584	630	774	770
1 - Sum af EBVmilk	316	575	612	569	493	570	638	652	622	663	602	670	713	698	765	644
1 - Sum af EBVmilk_ped	211	364	432	418	415	499	574	618	597	638	585	657	707	684	757	645
1 - Sum af GEBVmilk	250	477	432	502	451	516	589	660	649	730	698	778	840	862	1026	983
1 - Sum af GEBVmilk_ped	190	344	393	390	394	462	545	604	599	650	608	693	766	777	905	851
0 - Sum af _FREQ_	211124	209923	204706	211413	205480	211496	214790	210303	208074	207508	201927	197198	189790	181400	155447	42246
1 - Sum af _FREQ_	24	121	205	352	449	767	1119	1565	3094	4770	7750	8799	10523	15579	22257	9621

Figure 11 EBV and GEBV trend vs pedigree trend for milk combined (1-3 lact) for females with own records.



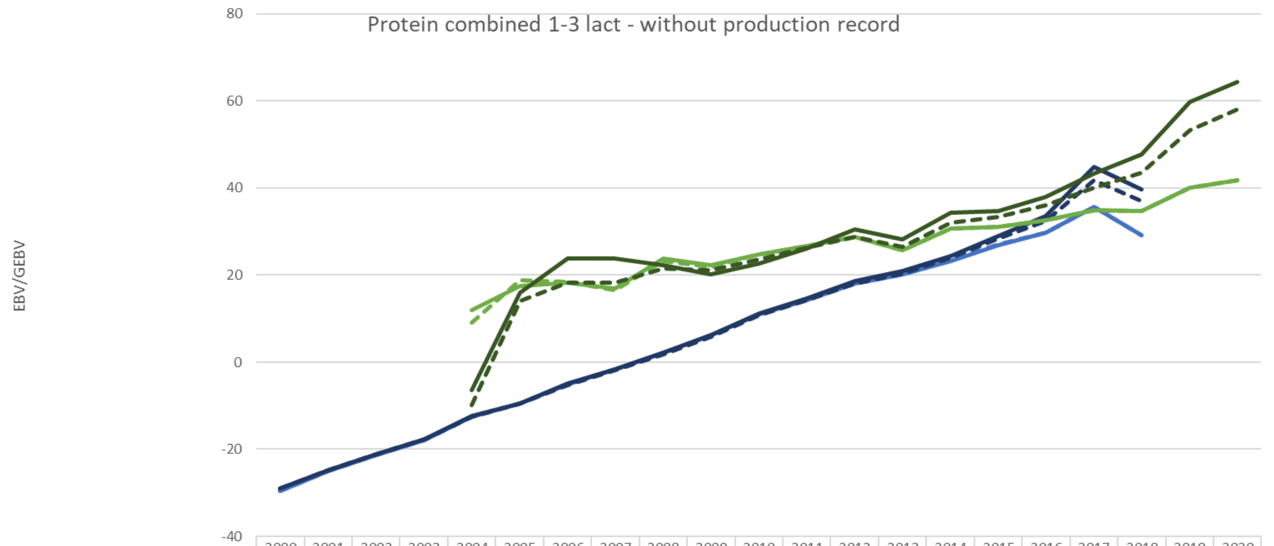
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
0 - Sum af EBVmilk	-797	-651	-555	-464	-328	-253	-118	-36	77	173	286	362	427	466	471	573	580	726	464		
0 - Sum af EBVmilk_ped	-794	-649	-553	-462	-328	-251	-115	-31	71	174	290	364	427	468	476	578	580	726	464		
0 - Sum af GEBVmilk	-783	-642	-548	-459	-324	-251	-116	-36	74	170	289	363	439	483	499	625	679	974	739		
0 - Sum af GEBVmilk_ped	-783	-644	-549	-459	-329	-253	-121	-38	63	163	282	356	425	470	490	612	648	890	683		
1 - Sum af EBVmilk					385	569	629	401	534	623	652	657	678	581	659	672	669	733	695	855	893
1 - Sum af EBVmilk_ped					280	663	588	409	524	625	654	660	680	580	660	672	670	733	695	855	893
1 - Sum af GEBVmilk					-349	343	1024	507	461	566	600	636	742	671	776	785	829	998	1061	1363	1458
1 - Sum af GEBVmilk_ped					-322	469	623	432	483	607	629	644	679	602	696	730	764	881	930	1170	1268
0 - Sum af _FREQ_	6172	5943	5612	5583	5818	5726	5758	5532	5695	5765	5719	6264	6103	4941	4656	3658	1390	456	145		
1 - Sum af _FREQ_					1	8	10	9	34	86	134	265	498	1064	1452	2300	4038	7264	31786	44051	11802

Figure 12 EBV and GEBV trend vs pedigree trend for milk combined (1-3 lact) for females without own records.



	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
0 - Sum af EBVprotein	-15	-11	-8	-3	1	4	8	12	14	18	19	22	26	28	32	31
0 - Sum af EBVprotein_ped	-15	-11	-8	-3	1	4	8	12	14	18	19	22	26	28	32	31
0 - Sum af GEBVprotein	-15	-11	-7	-3	1	4	8	12	14	18	20	23	27	30	35	36
0 - Sum af GEBVprotein_ped	-15	-11	-8	-3	1	3	8	12	14	18	20	23	27	30	35	36
1 - Sum af EBVprotein_ped	5	16	19	16	16	20	22	24	24	26	26	30	32	33	36	34
1 - Sum af GEBVprotein	12	21	21	19	18	20	22	26	26	30	30	35	37	40	46	46
1 - Sum af GEBVprotein_ped	5	15	18	15	15	18	21	24	24	27	27	32	35	37	42	41
1 - Sum af EBVprotein	14	25	27	21	19	22	23	26	25	27	26	31	33	34	36	34

Figure 13 EBV and GEBV trend vs pedigree trend for protein combined (1-3 lact) for females with own records.

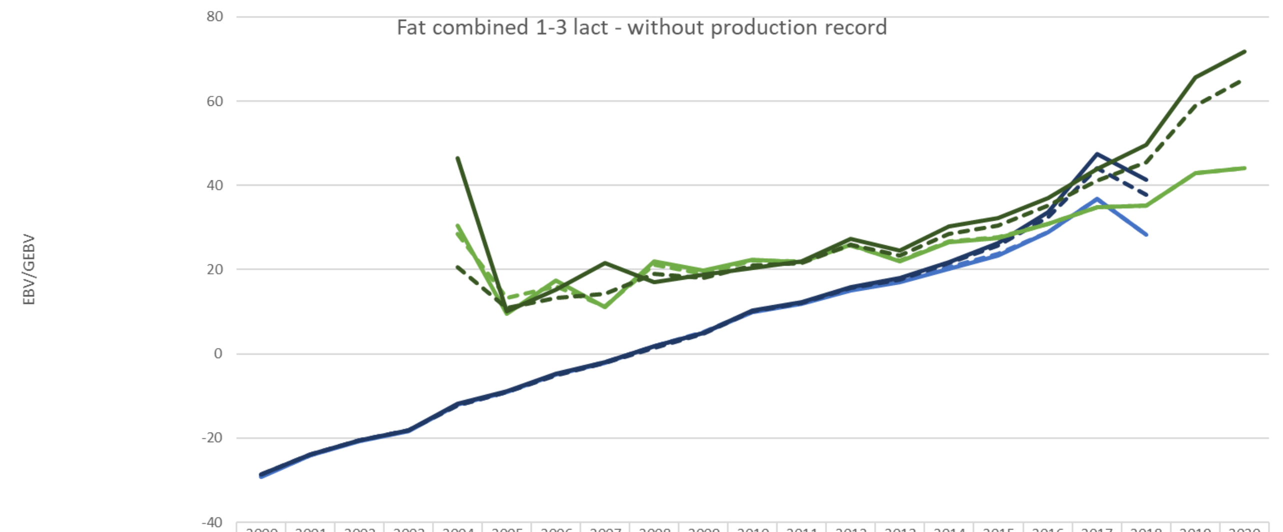


	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
0 - Sum af EBVprotein	-30	-25	-21	-18	-13	-10	-5	-2	2	6	11	14	18	20	23	27	30	36	29		
0 - Sum af EBVprotein_ped	-30	-25	-21	-18	-13	-9	-5	-2	2	6	11	14	18	20	23	27	30	36	29		
0 - Sum af GEBVprotein	-29	-25	-21	-18	-12	-9	-5	-2	2	6	11	15	19	21	24	29	34	45	40		
0 - Sum af GEBVprotein_ped	-29	-25	-21	-18	-13	-10	-5	-2	2	6	11	14	18	20	24	28	32	42	37		
1 - Sum af EBVprotein					12	18	18	17	24	22	25	27	29	26	31	31	33	35	35	40	42
1 - Sum af EBVprotein_ped					9	19	18	17	23	22	25	27	29	26	31	31	33	35	35	40	42
1 - Sum af GEBVprotein					-6	16	24	24	22	20	23	26	31	28	34	35	38	43	48	60	64
1 - Sum af GEBVprotein_ped					-10	14	18	18	21	21	24	26	29	27	32	33	36	40	43	53	58

Figure 14 EBV and GEBV trend vs pedigree trend for protein combined (1-3 lact) for females without own records.

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
0 - Sum af EBVfat	-14	-9	-6	-2	1	3	6	11	12	15	16	19	22	26	32	30
0 - Sum af EBVfat_ped	-14	-9	-6	-2	1	3	6	11	12	15	16	19	22	26	32	30
0 - Sum af GEBVfat	-14	-9	-6	-2	1	3	6	11	12	15	17	20	24	29	37	36
0 - Sum af GEBVfat_ped	-14	-9	-6	-2	1	3	6	11	12	15	16	20	24	29	36	36
1 - Sum af EBVfat	20	24	30	23	19	21	21	24	20	23	22	27	29	32	37	33
1 - Sum af EBVfat_ped	11	15	21	18	16	18	19	23	19	22	22	27	29	32	37	33
1 - Sum af GEBVfat	16	20	24	21	17	19	19	24	22	26	26	32	35	39	48	47
1 - Sum af GEBVfat_ped	10	14	19	16	15	17	18	22	20	23	23	28	32	36	44	42

Figure 15 EBV and GEBV trend vs pedigree trend for fat combined (1-3 lact) for females with own records.



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
0 - Sum af EBVfat	-29	-24	-21	-18	-12	-9	-5	-2	2	5	10	12	15	17	20	23	29	37	28		
0 - Sum af EBVfat_ped	-29	-24	-21	-18	-12	-9	-5	-2	2	5	10	12	15	17	21	24	29	37	28		
0 - Sum af GEBVfat	-29	-24	-20	-18	-12	-9	-5	-2	2	5	10	12	16	18	22	26	34	48	41		
0 - Sum af GEBVfat_ped	-29	-24	-20	-18	-12	-9	-5	-2	1	5	10	12	16	18	22	26	32	44	38		
1 - Sum af EBVfat					31	9	17	11	22	20	22	22	26	22	27	28	31	35	35	43	44
1 - Sum af EBVfat_ped					29	13	16	11	21	19	22	22	26	22	27	28	31	35	35	43	44
1 - Sum af GEBVfat					46	10	15	22	17	19	20	22	27	24	30	32	37	44	50	66	72
1 - Sum af GEBVfat_ped					21	11	13	14	19	18	21	21	26	23	28	30	35	41	46	59	65

Figure 16 EBV and GEBV trend vs pedigree trend for fat combined (1-3 lact) for females without own records.

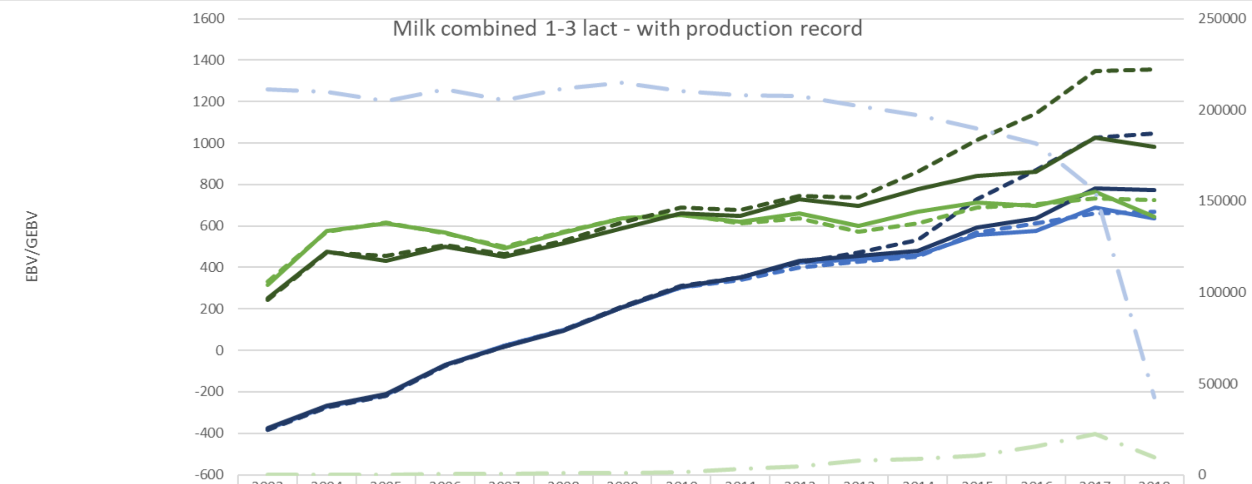
If we look at the genotyped animals, it is seen that for animals without production records (Figure 12, Figure 14 and Figure 16) the level of the GEBV is higher than the pedigree index based on GEBV in especially the later years. It should however be noticed from Figure 12 that in the yearclasses from 2004-2011 for genotyped females without production records, there are only a limited number of animals (1-265 obs per year class).
For genotyped females with and without own performance records, the average GEBV per year class is in gereal higher than average pedigree index based on parenst GEBVs. In the later yearclasses, where the EBV and pedigree index based on parents EBVs are at the same level, these results are highly unexpected and not easy to give a reasonable explanation for.

Full and reduced data EBV/GEBV

In Figure 17 to Figure 22 trends for full vs reduced models are shown for females with (Figure 17, Figure 19 and Figure 21) and without (Figure 18, Figure 20 and Figure 22) own production records, respectively. Green coloured lines are for genotyped animals, whereas blue lines are results for non-genotyped animals. Darker colours are GEBVs while brighter colours are EBVs. Finally, broken lines are showing results from the reduced evaluation, where 4 years of phenotypic data are cut of, and full lines are from the full dataset with all phenotypic data included. In Figure 17 and Figure 18 the number of observations can also be seen for genotyped and non-genotyped animals.
In Figure 17 and Figure 18 we see that for the EBVs (brighter colored lines) that full and reduced data are following each other pretty closely for milk yield. This was perhaps not expected for the later year classes, as we would expect that the sires of these animals are selected based on a GEBV and thus expected to have a positive mendelian sampling term. Therefor we would also expect that the full lines should be at a little higher level than the broken lines, as there should be data available showning this selection path. An explenation why we actually do not see a difference could be, that there is actually not much selection for milk yiled, as this is weighted negatively in the yild index. For protein yield (Figure 19 and Figure 20) we se as expected that the trend from the full evaluation is higher than for the reduced evaluation for the later birth year classes, whereas for fat yield (Figure 21 and Figure 22) we se only a slight increase in trend in the full evaluation.
For the GEBVs we would however expect that the full and the reduced run follows similar trend, as the selection made on young genotyped sires is acconted for. This is seen for all three yield traits and for

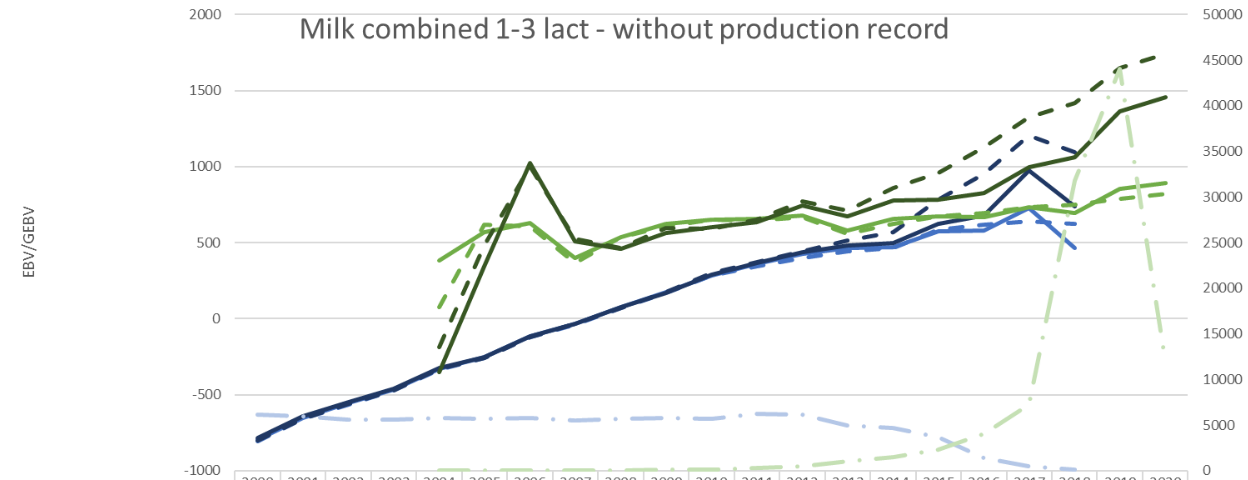
genotyped and non-genotyped animals with and without own production records. It can se seen for birthyear classes 2019 and 2020 (genotyped females without own production records) that the difference between the full and the reduced runs seem to decrease compared to birthyear classes 2017 and 2018. This might also be related to phenomenon seen in Figure 11 - Figure 16, where it was seen that genotyped animals without own perfomance records on avaerage had a higher GEBV than what was epected from the pedigree.

In conclusion there seems to be some challenges with both the traditional EBVs that do not account for the selection on genotypic information and the SS GEBVs where the trend in the reduced data seems to be overestimated as well as genotyped non selected animals tend to have on average a higher level than the parent average which is not logical.



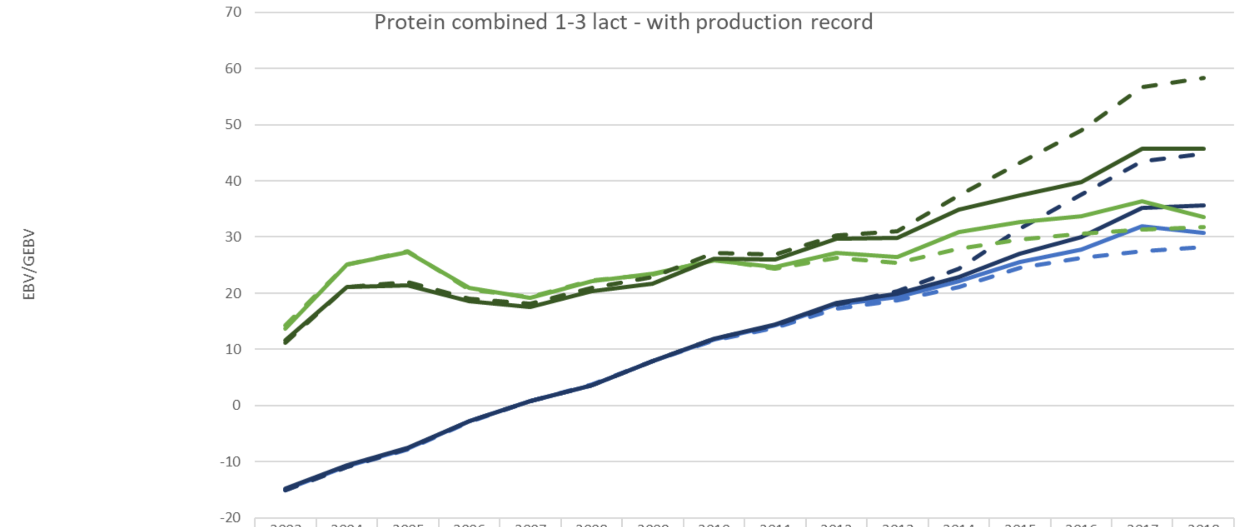
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
0 - Sum af EBVmilk	-378	-270	-215	-72	21	98	209	305	350	424	441	458	555	578	690	638
0 - Sum af EBVredmilk	-383	-275	-218	-73	21	99	209	304	338	400	426	451	570	613	660	670
0 - Sum af GEBVmilk	-374	-268	-212	-70	20	96	206	307	353	430	454	481	593	635	780	774
0 - Sum af GEBVredmilk	-383	-275	-217	-73	20	98	210	312	352	422	471	533	731	870	1025	1046
1 - Sum af EBVmilk	316	575	612	569	493	570	638	652	622	663	602	670	713	698	765	644
1 - Sum af EBVredmilk	333	574	616	563	499	573	636	658	611	638	572	614	690	704	732	725
1 - Sum af GEBVmilk	250	477	432	502	451	516	589	660	649	730	698	778	840	862	1026	983
1 - Sum af GEBVredmilk	243	471	455	509	466	527	615	688	677	747	737	862	1014	1143	1346	1355
0 - Sum af _FREQ_	211124	209923	204706	211413	205480	211496	214790	210303	208074	207508	201927	197198	189790	181400	155447	42246
1 - Sum af _FREQ_	24	121	205	352	449	767	1119	1565	3094	4770	7750	8799	10523	15579	22257	9621

Figure 17 Full and reduced EBV/GEBV trend for milk combined (1-3 lact) for females with own production records.



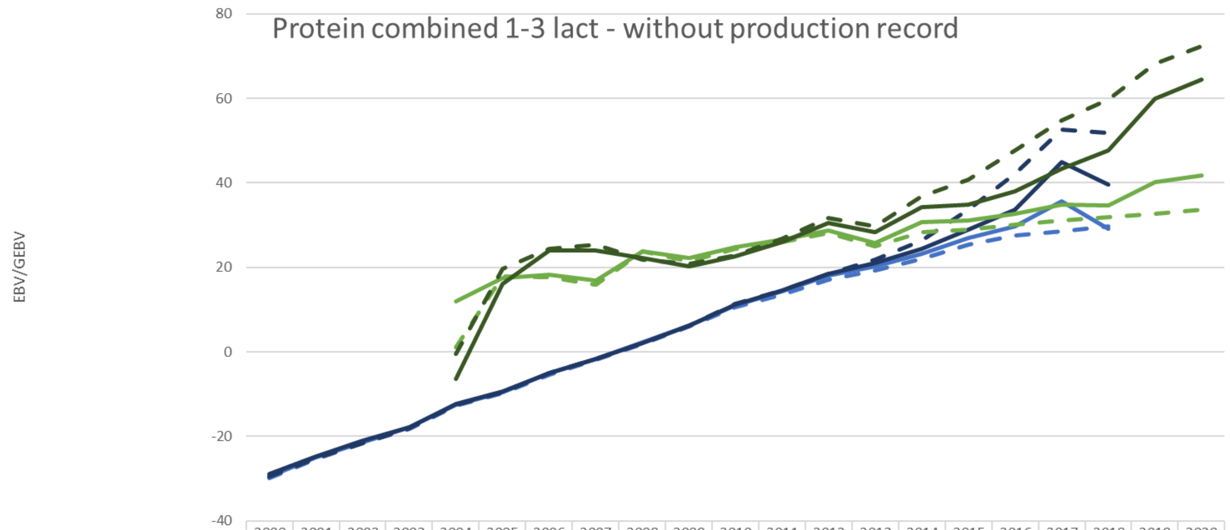
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
0 - Sum af EBVmilk	-797	-651	-555	-464	-328	-253	-118	-36	77	173	286	362	427	466	471	573	580	726	464		
0 - Sum af EBVredmilk	-807	-660	-564	-472	-336	-260	-124	-39	69	168	281	345	400	446	463	588	617	639	624		
0 - Sum af GEBVmilk	-783	-642	-548	-459	-324	-251	-116	-36	74	170	289	363	439	483	499	625	679	974	739		
0 - Sum af GEBVredmilk	-799	-657	-560	-471	-331	-256	-119	-36	72	173	300	371	440	512	568	781	950	1204	1094		
1 - Sum af EBVmilk					385	569	629	401	534	623	652	657	678	581	659	672	669	733	695	855	893
1 - Sum af EBVredmilk					76	618	608	368	537	609	652	644	665	558	623	671	696	732	749	788	821
1 - Sum af GEBVmilk					-349	343	1024	507	461	566	600	636	742	671	776	785	829	998	1061	1363	1458
1 - Sum af GEBVredmilk					-190	483	1001	527	467	598	590	651	770	710	858	958	1125	1324	1418	1646	1741
0 - Sum af _FREQ_	6172	5943	5612	5583	5818	5726	5758	5532	5695	5765	5719	6264	6103	4941	4656	3658	1390	456	145		
1 - Sum af _FREQ_					1	8	10	9	34	86	134	265	498	1064	1452	2300	4038	7264	31786	44051	11802

Figure 18 Full and reduced EBV/GEBV trend for milk combined (1-3 lact) for females without own production records.



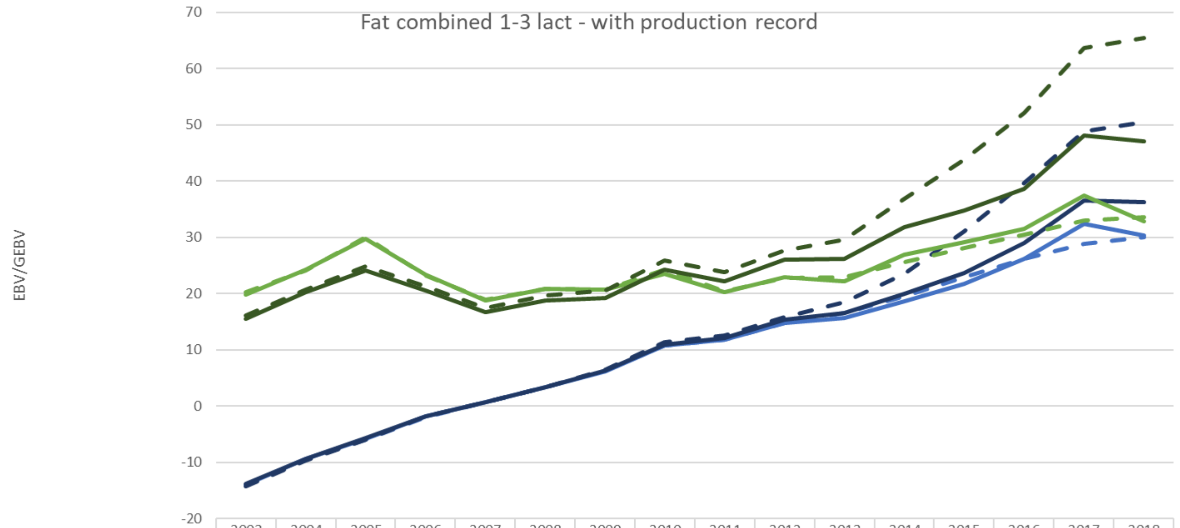
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
0 - Sum af EBVprotein	-15	-11	-8	-3	1	4	8	12	14	18	19	22	26	28	32	31
0 - Sum af EBVredprotein	-15	-11	-8	-3	1	4	8	12	14	17	19	21	24	26	27	28
0 - Sum af GEBVprotein	-15	-11	-7	-3	1	4	8	12	14	18	20	23	27	30	35	36
0 - Sum af GEBVredprotein	-15	-11	-8	-3	1	4	8	12	14	18	20	24	31	38	43	45
1 - Sum af EBVprotein	14	25	27	21	19	22	23	26	25	27	26	31	33	34	36	34
1 - Sum af EBVredprotein	14	25	27	21	19	22	23	26	24	26	25	28	30	31	31	32
1 - Sum af GEBVprotein	12	21	21	19	18	20	22	26	26	30	30	35	37	40	46	46
1 - Sum af GEBVredprotein	11	21	22	19	18	21	23	27	27	30	31	37	43	49	57	58

Figure 19 Full and reduced EBV/GEBV trend for protein combined (1-3 lact) for females with own production records.



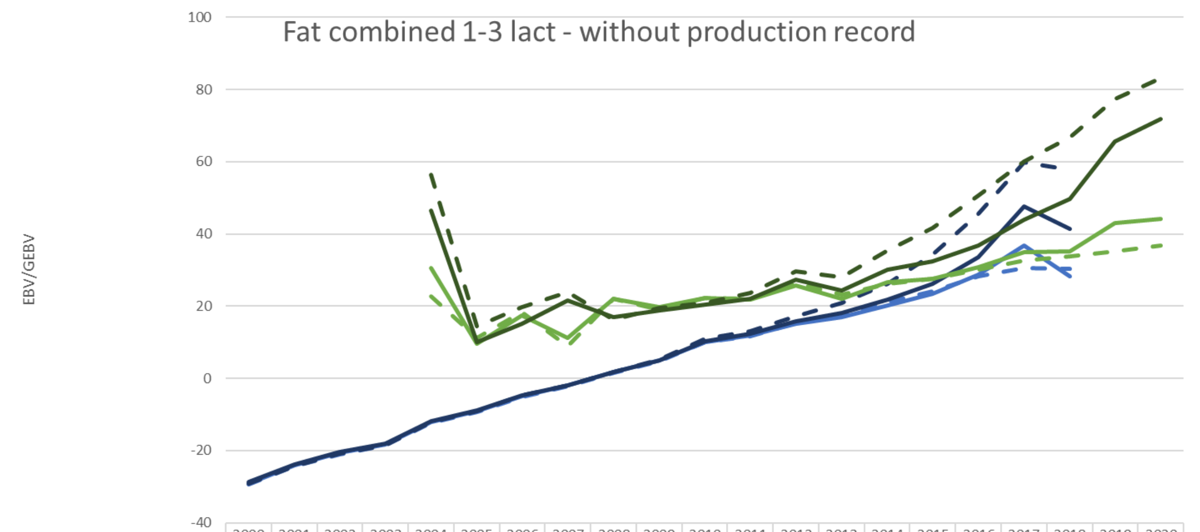
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
0 - Sum af EBVprotein	-30	-25	-21	-18	-13	-10	-5	-2	2	6	11	14	18	20	23	27	30	36	29		
0 - Sum af EBVredprotein	-30	-25	-22	-18	-13	-10	-5	-2	2	6	11	14	17	19	22	25	28	28	30		
0 - Sum af GEBVprotein	-29	-25	-21	-18	-12	-9	-5	-2	2	6	11	15	19	21	24	29	34	45	40		
0 - Sum af GEBVredprotein	-30	-25	-22	-18	-13	-10	-5	-2	2	6	11	15	19	22	26	34	42	53	52		
1 - Sum af EBVprotein					12	18	18	17	24	22	25	27	29	26	31	31	33	35	35	40	42
1 - Sum af EBVredprotein					1	18	18	16	24	21	24	26	28	25	28	29	30	31	32	33	34
1 - Sum af GEBVprotein					-6	16	24	24	22	20	23	26	31	28	34	35	38	43	48	60	64
1 - Sum af GEBVredprotein					0	20	24	25	22	21	23	27	32	30	37	41	48	55	60	68	72

Figure 20 Full and reduced EBV/GEBV trend for protein combined (1-3 lact) for females without own production records.



	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
0 - Sum af EBVfat	-14	-9	-6	-2	1	3	6	11	12	15	16	19	22	26	32	30
0 - Sum af EBVredfat	-14	-10	-6	-2	1	3	6	11	12	15	17	20	23	26	29	30
0 - Sum af GEBVfat	-14	-9	-6	-2	1	3	6	11	12	15	17	20	24	29	37	36
0 - Sum af GEBVredfat	-14	-10	-6	-2	1	3	6	11	12	16	18	24	31	40	49	50
1 - Sum af EBVfat	20	24	30	23	19	21	21	24	20	23	22	27	29	32	37	33
1 - Sum af EBVredfat	20	24	30	23	19	21	21	24	20	23	23	26	28	30	33	34
1 - Sum af GEBVfat	16	20	24	21	17	19	19	24	22	26	26	32	35	39	48	47
1 - Sum af GEBVredfat	16	21	25	21	17	20	20	26	24	28	30	37	44	52	64	65

Figure 21 Full and reduced EBV/GEBV trend for fat combined (1-3 lact) for females with own production records.



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
0 - Sum af EBVfat	-29	-24	-21	-18	-12	-9	-5	-2	2	5	10	12	15	17	20	23	29	37	28		
0 - Sum af EBVredfat	-29	-24	-21	-18	-12	-9	-5	-2	2	5	10	12	15	18	21	24	28	31	30		
0 - Sum af GEBVfat	-29	-24	-20	-18	-12	-9	-5	-2	2	5	10	12	16	18	22	26	34	48	41		
0 - Sum af GEBVredfat	-29	-24	-21	-18	-12	-9	-5	-2	2	5	11	13	17	21	26	34	46	60	58		
1 - Sum af EBVfat					31	9	17	11	22	20	22	22	26	22	27	28	31	35	35	43	44
1 - Sum af EBVredfat					23	11	18	9	22	19	22	22	26	23	26	28	30	33	34	35	37
1 - Sum af GEBVfat					46	10	15	22	17	19	20	22	27	24	30	32	37	44	50	66	72
1 - Sum af GEBVredfat					56	14	20	24	16	19	21	24	30	28	36	42	51	60	67	77	83

Figure 22 Full and reduced EBV/GEBV trend for fat combined (1-3 lact) for females without own production records.

Appendix 1.

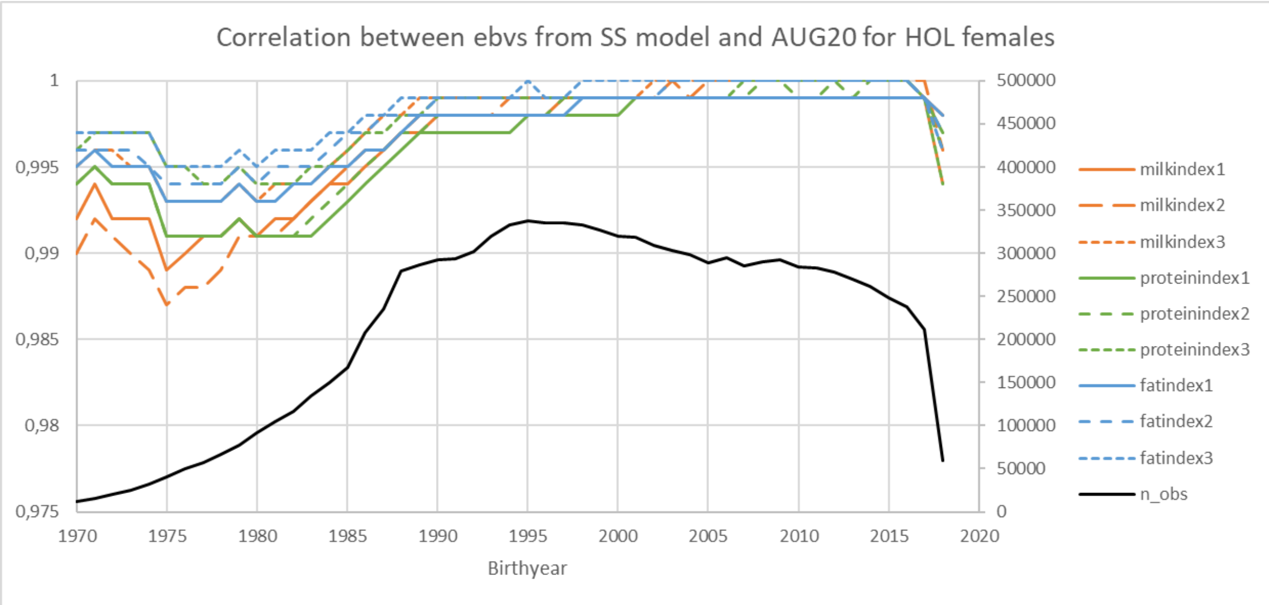


Figure 1 Correlations between EBVs from SS model and AUG20 routine run for yield traits for fimales. Birth year 2019 not shown as it has only 3 observations.

In Figure 2 the trend for females in the 2 evaluations without genomic data is compared. To compare trends the SS evaluation without genomic information have been scaled to have same mean and standard deviation as females born in 2005. It can be seen from the figure that the trend is similar for the two evaluations even though the trend of the EBVs from SS model without genomic information is slightly steeper than the official AUG20 evaluation trend.

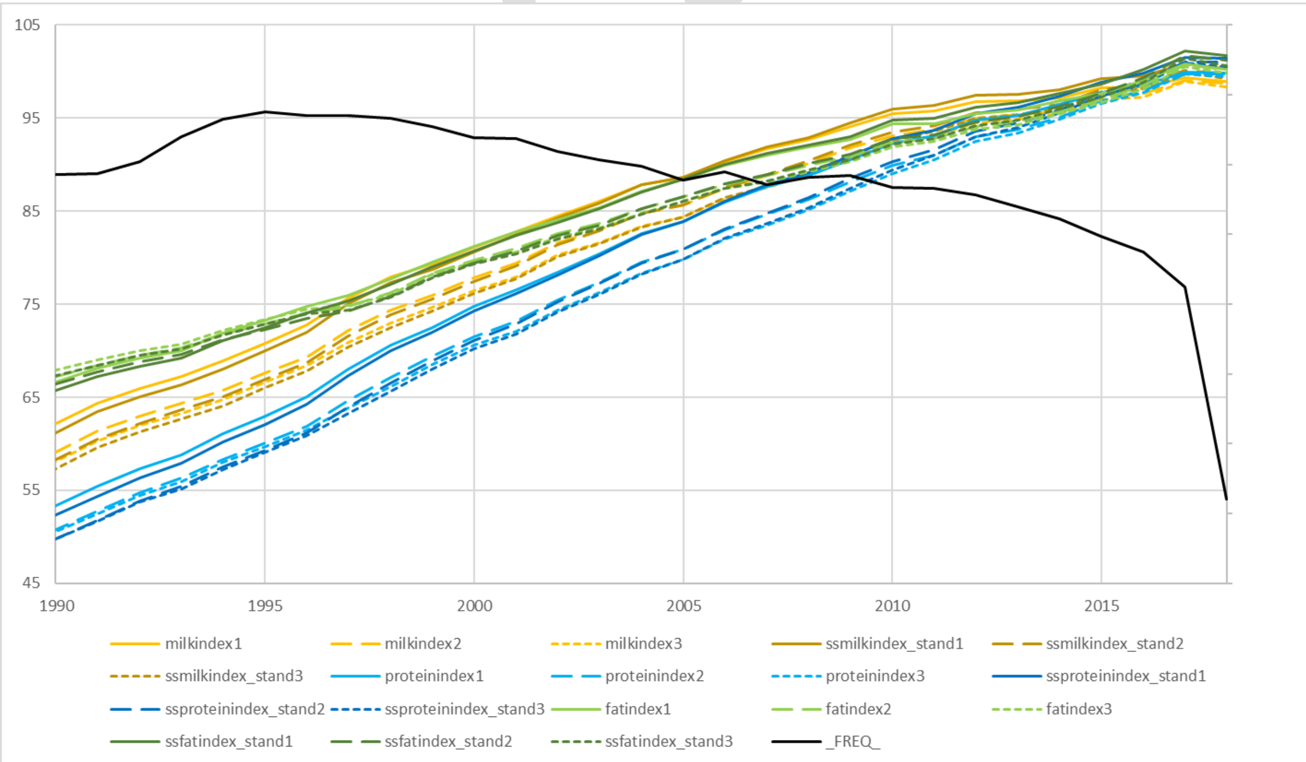


Figure 2 Genetic trend of females for milkindex1- milkindex3, proteinindex1- proteinindex3, fatindex1- fatindex3. AUG20 is routine evaluation from August 2020 and SS_EBV is results from the SS_model without genomic information where indices are standardized so that females born in 2005 have same mean and standard deviation.

Males

188,215 records were read from the bullEBVfull file with EBVs from the SS model (without genomic data included). 64,817 records were read from the AUG20 routine phenotypic evaluation for yield traits.
64,668 records were found in both input datasets (99,77% of records in the AUG20 routine evaluation), while 149 records were available only from the AUG20 routine evaluation and 123,547 records were available only from the bullEBVfull file. These extra animals from bullEBVfull file are distributed fairly evenly from early 70's until 2020 with a slight overweight from 2012-2020 and from mid 90's-1999. The 149 animals only in the AUG20 evaluation are mainly bulls from CAN, DEU, NLD and USA.

As for females, the results are not scaled in the same way, but it is expected that correlations between are very high. However, there are slight differences between the two evaluations which might lead to minor differences as described for the females.

In Figure 3 correlation between EBVs by birthyear and yield trait from the SS model and the AUG20 routine phenotypic evaluation can be seen. Generally, correlations are high and above 0.99. But in the period from 2007 until 2013 they decrease especially for 1st laction traits. A table with all correlations can be found I Appendix 2.

If EBVs from the bullEBVfull file are standardized so that females born in 2005 have same mean and standarddeviation, the difference between milkindex1 from AUG20 and restandardized EBVs from the bullEBVfull file for bulls from birthyear 2013 range from -19 to +18 index units with an average difference of -1,24 index units. The most extreme differences are mainly for bulls born in DEU, NLD and USA. These were also the countries contribution mainly to 149 bulls not in available from the AUG20 file indicating, that the most extreme differences might be related to minor differences in the pedigree file and therefor related to differences in PHP grouping.

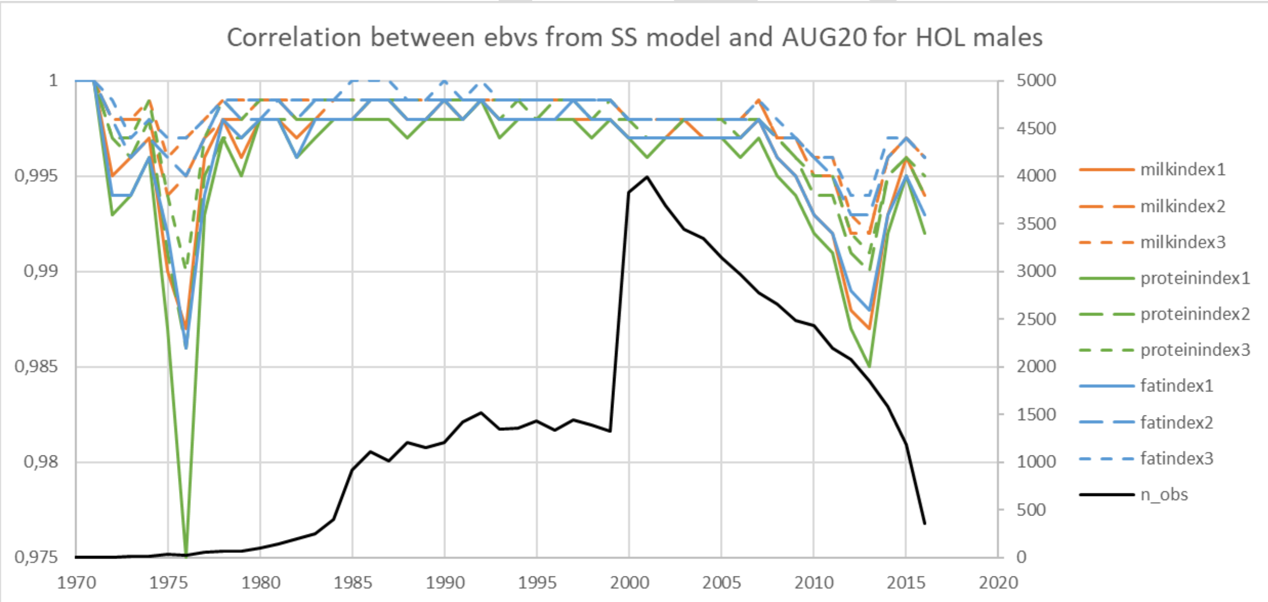


Figure 3 Correlations between EBVs from SS model and AUG20 routine run for yield traits for males. Birth year 2017 not shown as it has only 1 observation.

Pattern of the trend for males is similar to females with a slightly steeper trend for SS_EBV without genomic information compared to AUG20 evaluation.

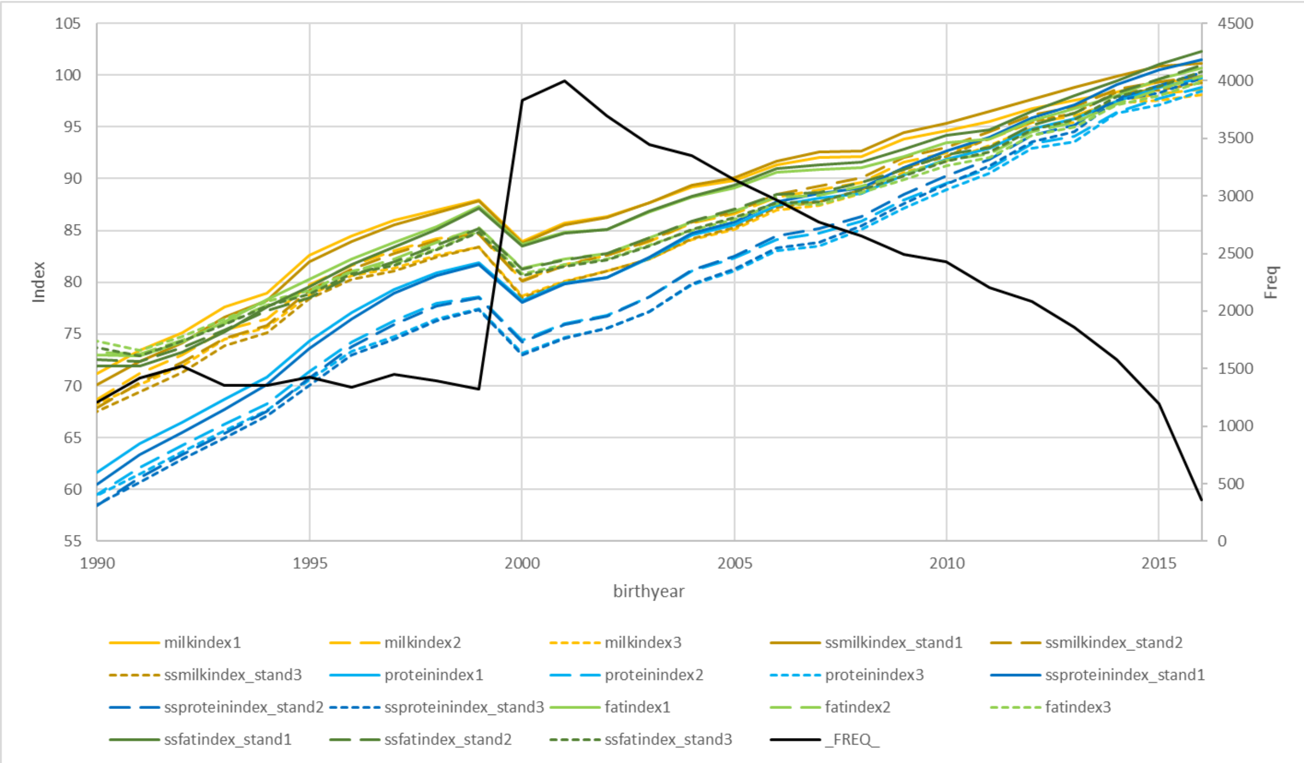


Figure 4 Genetic trend of males for milkindex1- milkindex3, proteinindex1- proteinindex3, fatindex1- fatindex3. AUG20 is routine evaluation from August 2020 and SS_EBV is results from the SS_model without genomic information where indices are standardized so that females born in 2005 have same mean and standard deviation.

It can be concluded that the EBVs from the SS model without genomic data is very similar to the EBVs from the routine evaluation and that EBVs from the SS model can be used for comparison of the GEBVs.

Compare EBVs and GEBVs from the SSmodel

In the following to compare GEBVs and EBVs, data from the same model with and without genotypes included are used. It is a GEBV model with QP transformation and allele frequency of 0.5.

Females

Below trend curves for EBVs and GEBVs are shown for milk (Figure 5), fat and protein (Figure 6). In the first figure is also a graph showing the number of observations per birthyear. The graphs cover genotyped and non-genotyped animals as well as animals with and without production records. For all three productions traits it is seen that the GEBV trend is steeper than the EBV trend. The difference is increasing in 2018 and is particularly big in 2019 and 2020. In 2019 and 2020 only 3 animals have production records out of almost 57,000 records in total for these two birthyears. The rest is genotyped animals without production. In 2018 approx. 35% of the records are from genotyped animals without production records and approx. 10% from genotyped animals with own production record. The rest is mainly non-genotyped animals with own production record. In 2017 and earlier most data are from animals with own production and the majority of these are non-genotyped. The distribution of data from different groups of animals can be seen in Figure 7

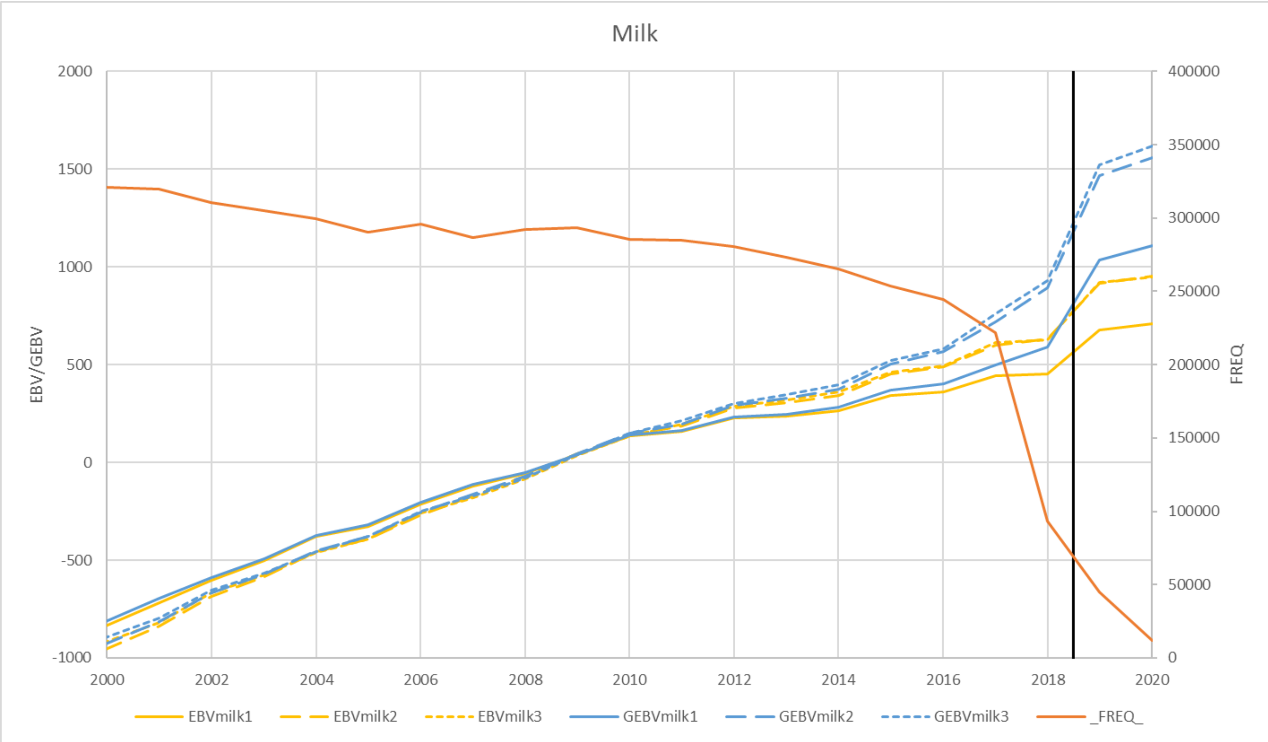


Figure 5 EBV and GEBV trends for milk traits. Blue curves are GEBVs and yellow curves are EBV. The orange curve is number of animals per birthyear. To the right of the vertical black line all animals do not have any phenotypic information.

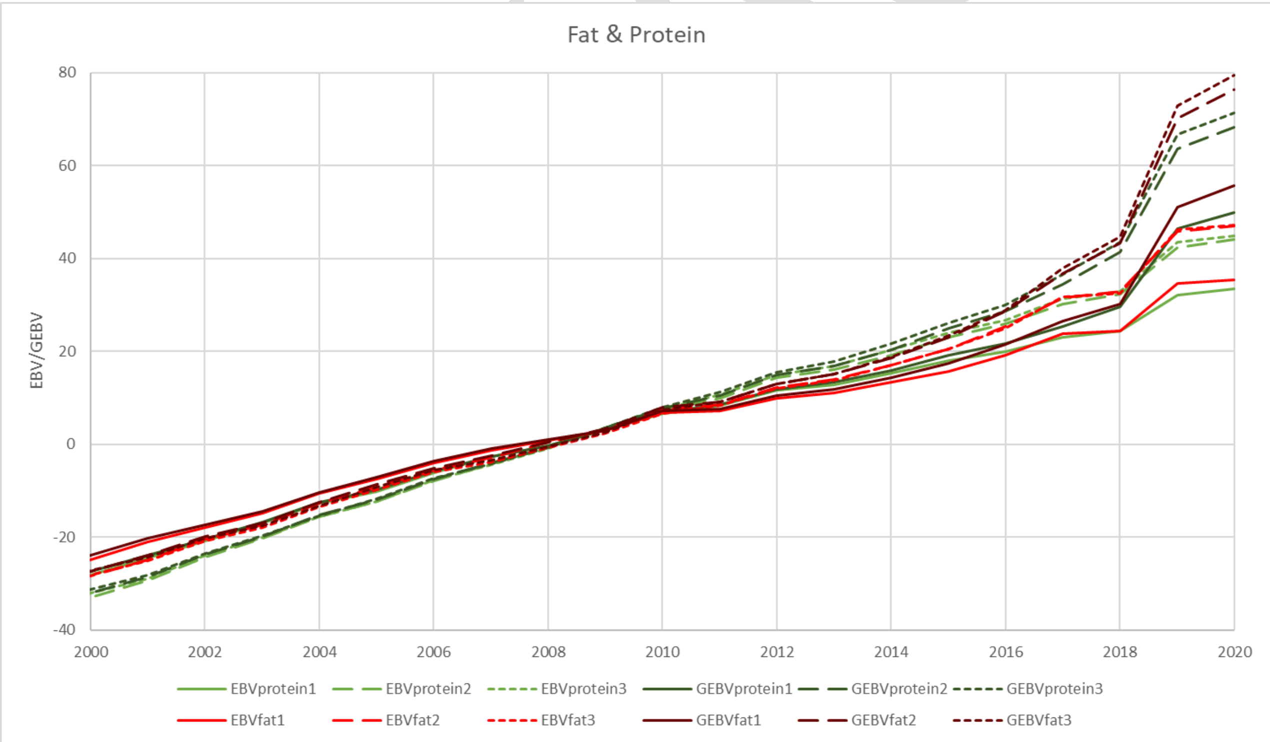


Figure 6 EBV and GEBV trends for fat (red curves) and protein (green curves) traits. Darker colored curves are GEBVs and lighter colored curves are EBVs.

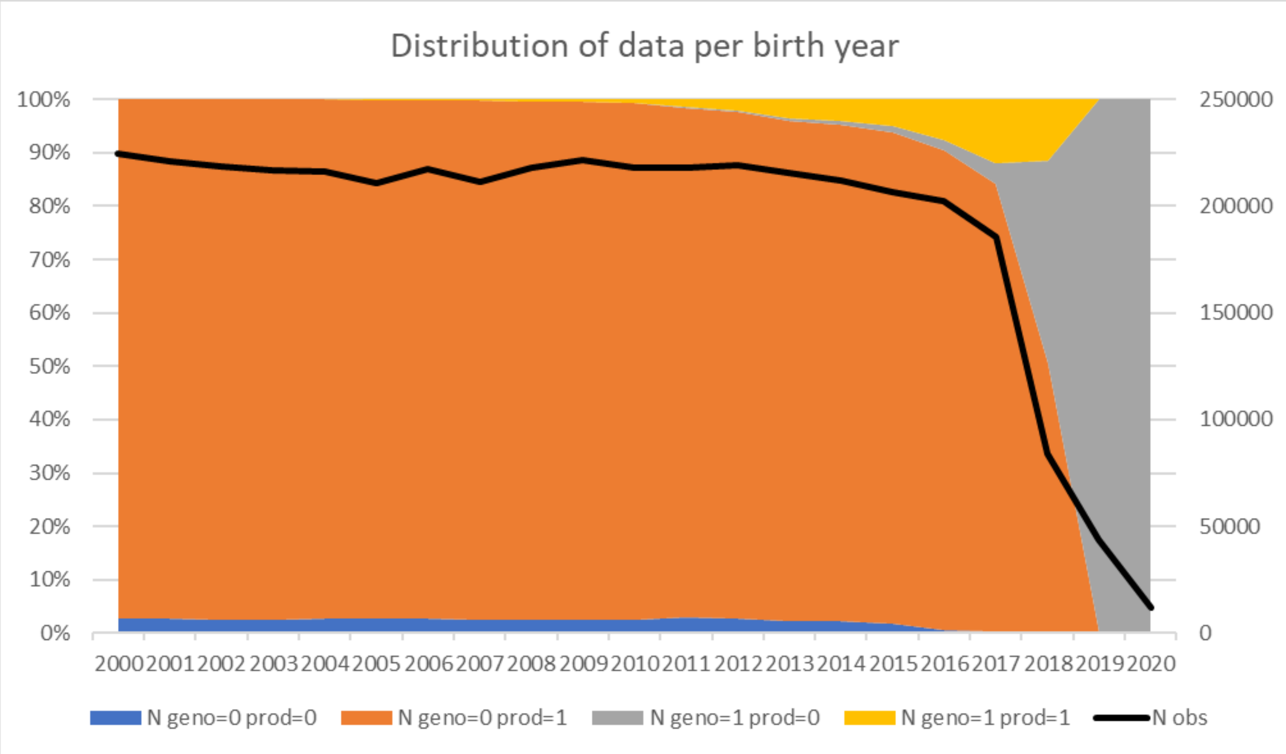


Figure 7 Distribution of data on groups of females. Non-genotyped cows with production (N geno=0 prod=1), genotyped cows with production (N geno=1 prod=1), non-genotyped females without production (N geno=0 prod=0) and genotyped females (heifers) without production (N geno=1 prod = 0). Number of observations in total per birthyear can be seen from the black curve.

In Figure 8 the difference between GEBVs and EBVs are shown for the different groups of females for the combined index for milk yield. It is seen that the difference between GEBV and EBV differs for non-genotyped cows with production record compared to the other groups, which are similar. The difference in 2018 between the curves for genotyped and non-genotyped cows with production record is 204 kg of milk corresponding to a little more than 3 milk index units. Similar graphs for protein and fat yield can be seen in Figure 9 and Figure 10. The pattern for protein and fat yield is like the pattern for milk yield.

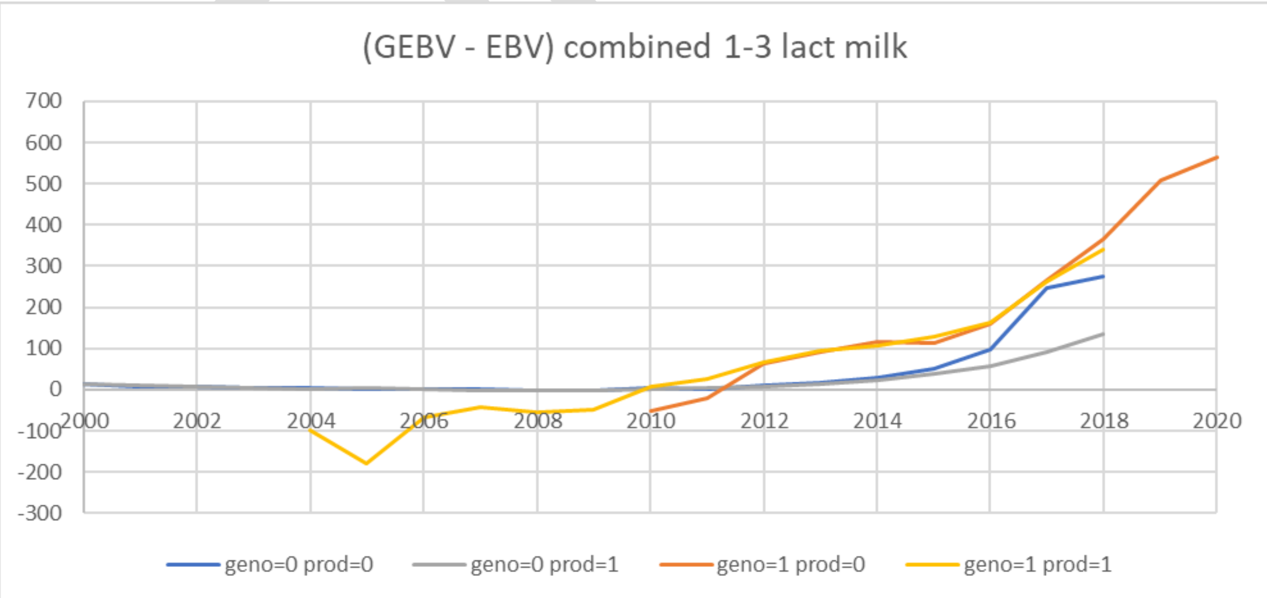


Figure 8 Difference between GEBV and EBV for the combined milk index calculated on groups of genotyped (geno=1) and non-genotyped (geno=0) females and females with (prod=1) and without (prod=0) production records in the full dataset.

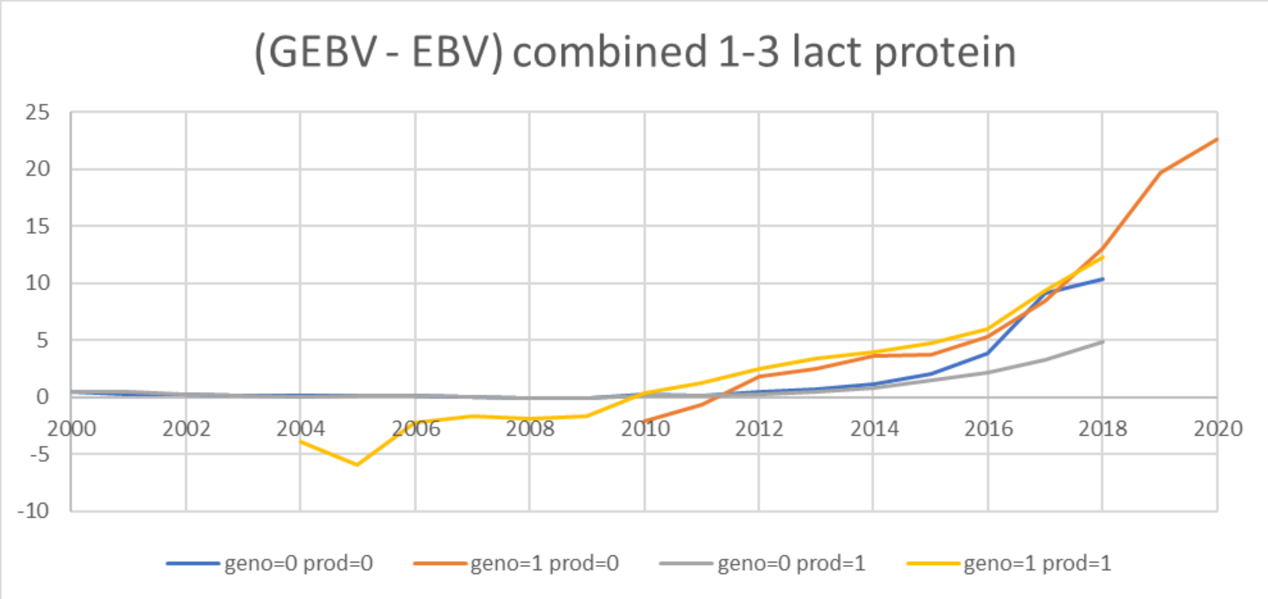


Figure 9 Difference between GEBV and EBV for the combined protein index calculated on groups of genotyped (geno=1) and non-genotyped (geno=0) females and females with (prod=1) and without (prod=0) production records in the full dataset.

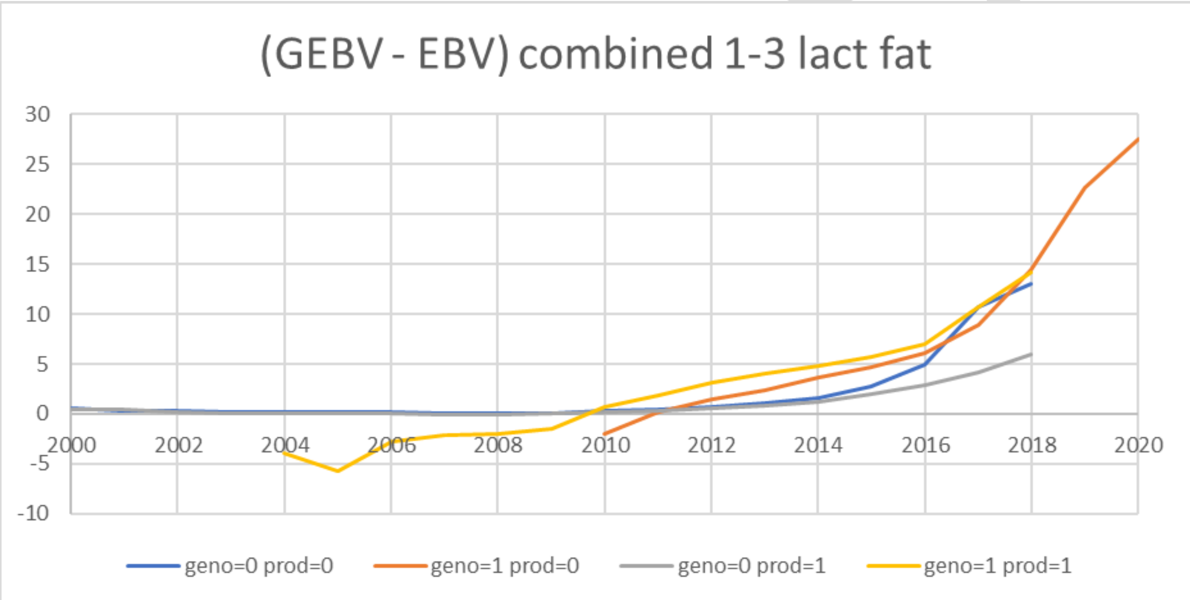


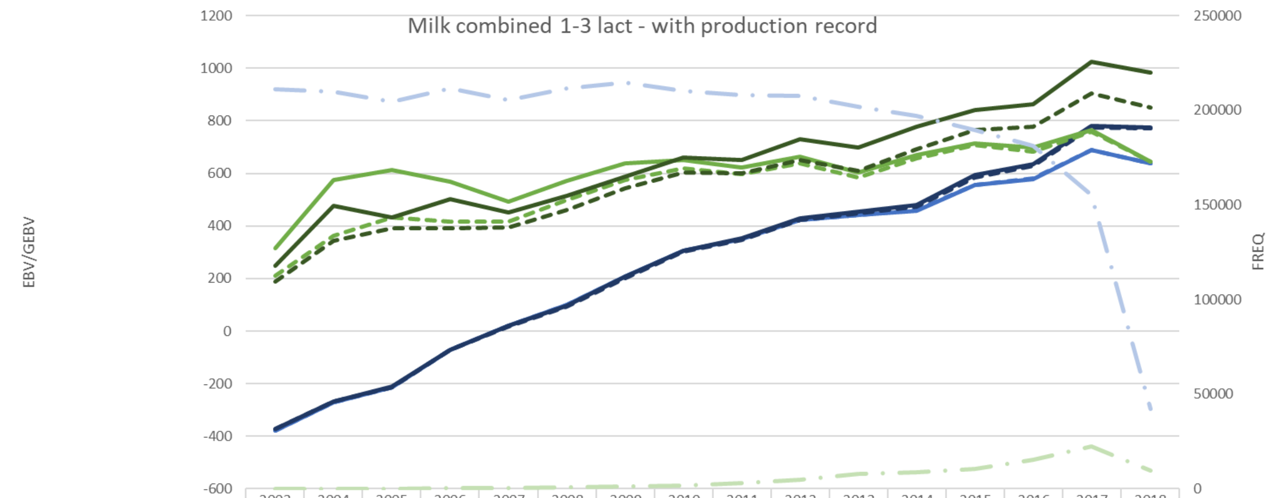
Figure 10 Difference between GEBV and EBV for the combined fat index calculated on groups of genotyped (geno=1) and non-genotyped (geno=0) females and females with (prod=1) and without (prod=0) production records in the full dataset.

The difference between non-genotyped and genotyped cows for (GEBV-EBV) is difficult to explain.

Pedigree index vs own index for EBV/GEBV

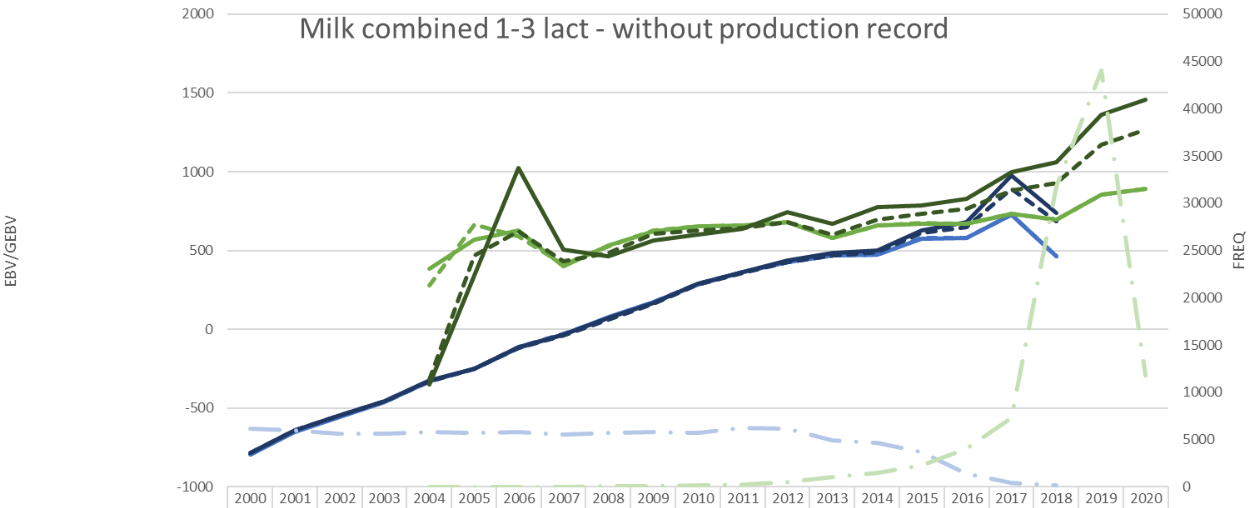
Earlier analysis indicated that production indices tend to increase when an animal get genomic tested. To test this, parent averages have been calculated for EBVs and GEBVs and compared with actual EBVs and GEBVs. As most females are genomic tested in a very young age, it is expected that average of the pedigree index would also be average of the actual EBVs/GEBVs as there has been no possibility to select animals on phenotypic data. The results can be seen in Figure 11 to Figure 16. Number of observations is only shown in Figure 11 and Figure 12, but number of observations in Figure 13 and Figure 15 is the same as in Figure 11 and similar the number of observations in Figure 14 and Figure 16 is the same as in Figure 12.

The figures show that no matter witch group of animals we look at, genotyped or non-genotyped and cows with own production records or females without production records, the EBVs and pedigree index based on EBVs are following each other nicely in the later year classes. For genotyped cows with own production records it is seen that in the period from 2003 until approx. 2013 the EBVs are higher than the EBV pedigree index, which indicate that these cows were selected on their index/own performance before they were genotyped. For non-genotyped cows with own performance records, the GEBV and pedigree index based on the GEBV is also following nicely in the whole period. For non-genotyped females without own performance records, the GEBV and pedigree index based on GEBV is also following each other nicely until 2016, where they start deviating a bit, so that the average GEBV for birth year classes 2017 and 2018 is slightly higher than average pedigree index based on GEBV. These two year classes are small and exists of females that have a genotyped offspring.



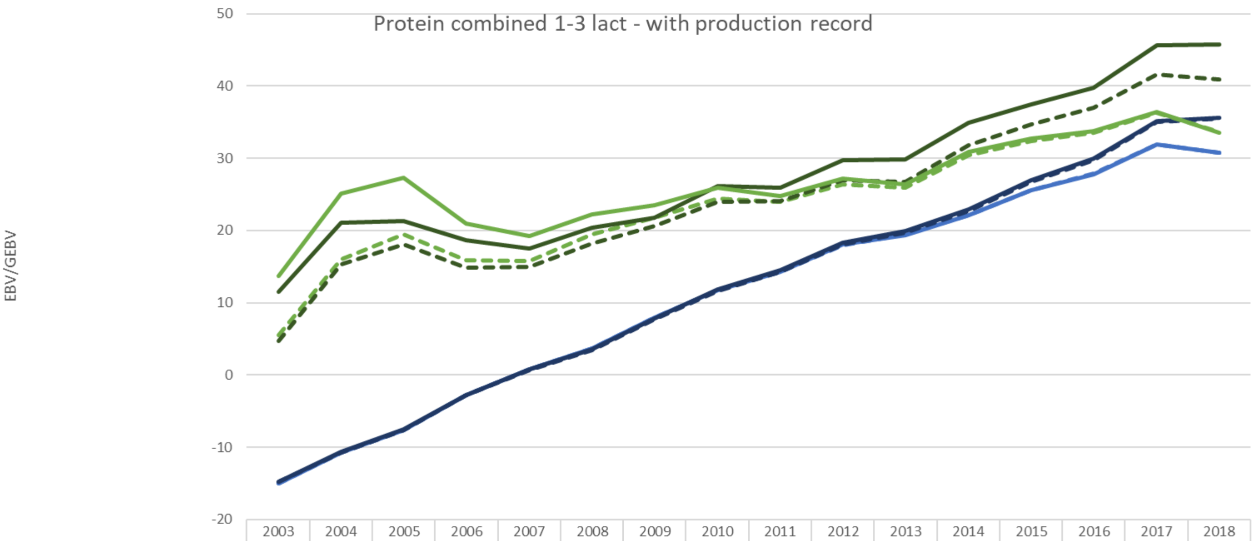
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
0 - Sum af EBVmilk	-378	-270	-215	-72	21	98	209	305	350	424	441	458	555	578	690	638
0 - Sum af EBVmilk_ped	-377	-270	-215	-70	20	99	209	304	352	424	443	461	556	581	690	638
0 - Sum af GEBVmilk	-374	-268	-212	-70	20	96	206	307	353	430	454	481	593	635	780	774
0 - Sum af GEBVmilk_ped	-373	-268	-214	-71	16	93	202	301	348	423	448	473	584	630	774	770
1 - Sum af EBVmilk	316	575	612	569	493	570	638	652	622	663	602	670	713	698	765	644
1 - Sum af EBVmilk_ped	211	364	432	418	415	499	574	618	597	638	585	657	707	684	757	645
1 - Sum af GEBVmilk	250	477	432	502	451	516	589	660	649	730	698	778	840	862	1026	983
1 - Sum af GEBVmilk_ped	190	344	393	390	394	462	545	604	599	650	608	693	766	777	905	851
0 - Sum af _FREQ_	211124	209923	204706	211413	205480	211496	214790	210303	208074	207508	201927	197198	189790	181400	155447	42246
1 - Sum af _FREQ_	24	121	205	352	449	767	1119	1565	3094	4770	7750	8799	10523	15579	22257	9621

Figure 11 EBV and GEBV trend vs pedigree trend for milk combined (1-3 lact) for females with own records.



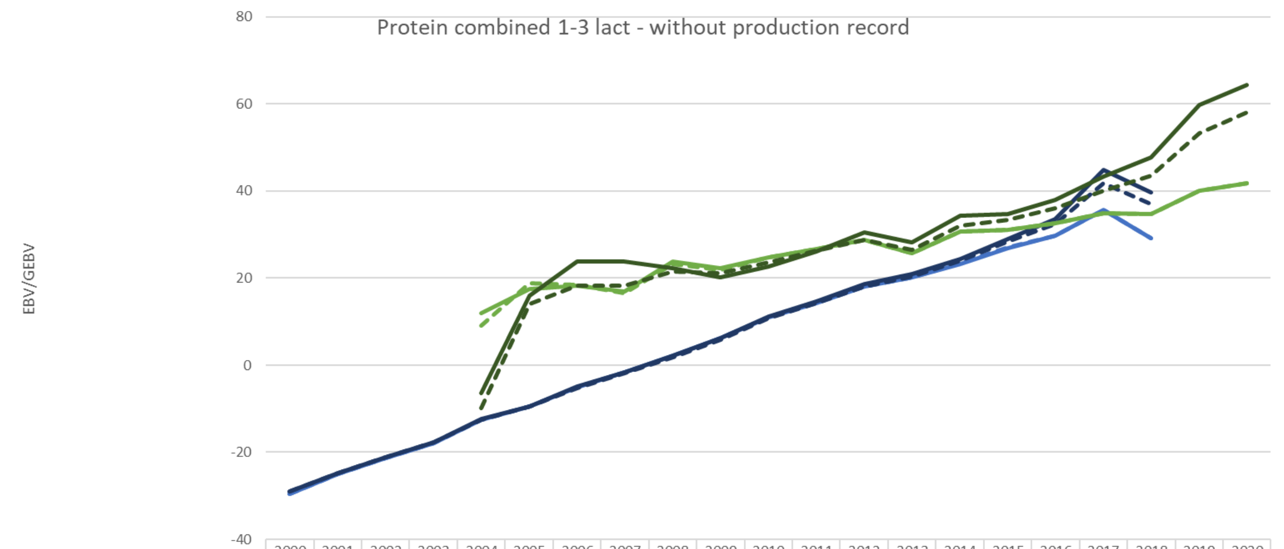
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
0 - Sum af EBVmilk	-797	-651	-555	-464	-328	-253	-118	-36	77	173	286	362	427	466	471	573	580	726	464		
0 - Sum af EBVmilk_ped	-794	-649	-553	-462	-328	-251	-115	-31	71	174	290	364	427	468	476	578	580	726	464		
0 - Sum af GEBVmilk	-783	-642	-548	-459	-324	-251	-116	-36	74	170	289	363	439	483	499	625	679	974	739		
0 - Sum af GEBVmilk_ped	-783	-644	-549	-459	-329	-253	-121	-38	63	163	282	356	425	470	490	612	648	890	683		
1 - Sum af EBVmilk					385	569	629	401	534	623	652	657	678	581	659	672	669	733	695	855	893
1 - Sum af EBVmilk_ped					280	663	588	409	524	625	654	660	680	580	660	672	670	733	695	855	893
1 - Sum af GEBVmilk					-349	343	1024	507	461	566	600	636	742	671	776	785	829	998	1061	1363	1458
1 - Sum af GEBVmilk_ped					-322	469	623	432	483	607	629	644	679	602	696	730	764	881	930	1170	1268
0 - Sum af _FREQ_	6172	5943	5612	5583	5818	5726	5758	5532	5695	5765	5719	6264	6103	4941	4656	3658	1390	456	145		
1 - Sum af _FREQ_					1	8	10	9	34	86	134	265	498	1064	1452	2300	4038	7264	31786	44051	11802

Figure 12 EBV and GEBV trend vs pedigree trend for milk combined (1-3 lact) for females without own records.



	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
0 - Sum af EBVprotein	-15	-11	-8	-3	1	4	8	12	14	18	19	22	26	28	32	31
0 - Sum af EBVprotein_ped	-15	-11	-8	-3	1	4	8	12	14	18	19	22	26	28	32	31
0 - Sum af GEBVprotein	-15	-11	-7	-3	1	4	8	12	14	18	20	23	27	30	35	36
0 - Sum af GEBVprotein_ped	-15	-11	-8	-3	1	3	8	12	14	18	20	23	27	30	35	36
1 - Sum af EBVprotein_ped	5	16	19	16	16	20	22	24	24	26	26	30	32	33	36	34
1 - Sum af GEBVprotein	12	21	21	19	18	20	22	26	26	30	30	35	37	40	46	46
1 - Sum af GEBVprotein_ped	5	15	18	15	15	18	21	24	24	27	27	32	35	37	42	41
1 - Sum af EBVprotein	14	25	27	21	19	22	23	26	25	27	26	31	33	34	36	34

Figure 13 EBV and GEBV trend vs pedigree trend for protein combined (1-3 lact) for females with own records.

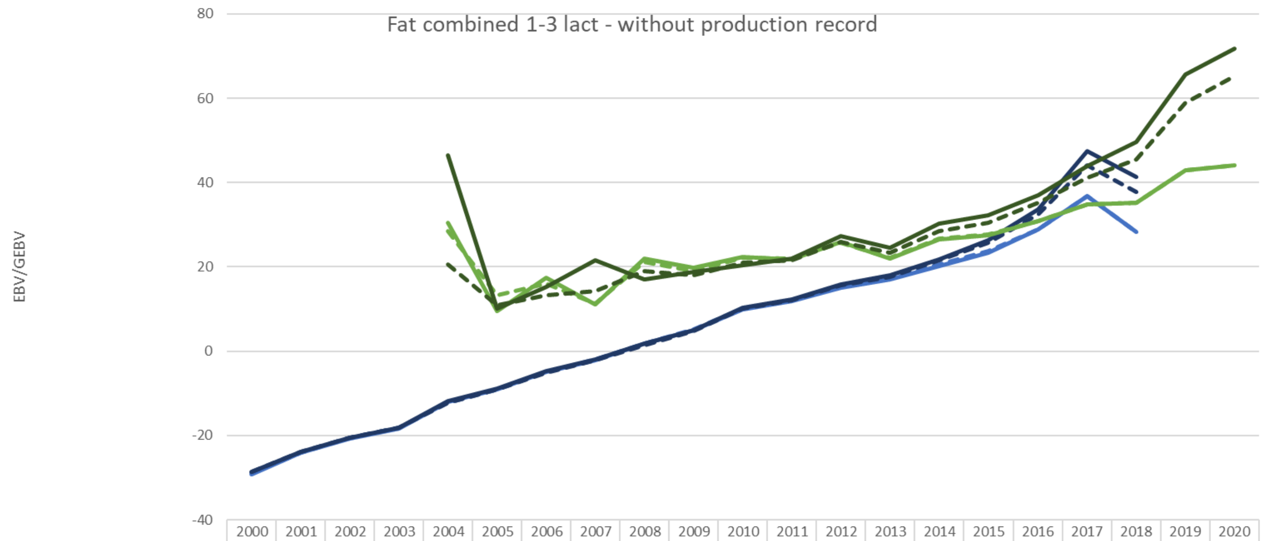


	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
0 - Sum af EBVprotein	-30	-25	-21	-18	-13	-10	-5	-2	2	6	11	14	18	20	23	27	30	36	29		
0 - Sum af EBVprotein_ped	-30	-25	-21	-18	-13	-9	-5	-2	2	6	11	14	18	20	23	27	30	36	29		
0 - Sum af GEBVprotein	-29	-25	-21	-18	-12	-9	-5	-2	2	6	11	15	19	21	24	29	34	45	40		
0 - Sum af GEBVprotein_ped	-29	-25	-21	-18	-13	-10	-5	-2	2	6	11	14	18	20	24	28	32	42	37		
1 - Sum af EBVprotein					12	18	18	17	24	22	25	27	29	26	31	31	33	35	35	40	42
1 - Sum af EBVprotein_ped					9	19	18	17	23	22	25	27	29	26	31	31	33	35	35	40	42
1 - Sum af GEBVprotein					-6	16	24	24	22	20	23	26	31	28	34	35	38	43	48	60	64
1 - Sum af GEBVprotein_ped					-10	14	18	18	21	21	24	26	29	27	32	33	36	40	43	53	58

Figure 14 EBV and GEBV trend vs pedigree trend for protein combined (1-3 lact) for females without own records.

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
0 - Sum af EBVfat	-14	-9	-6	-2	1	3	6	11	12	15	16	19	22	26	32	30
0 - Sum af EBVfat_ped	-14	-9	-6	-2	1	3	6	11	12	15	16	19	22	26	32	30
0 - Sum af GEBVfat	-14	-9	-6	-2	1	3	6	11	12	15	17	20	24	29	37	36
0 - Sum af GEBVfat_ped	-14	-9	-6	-2	1	3	6	11	12	15	16	20	24	29	36	36
1 - Sum af EBVfat	20	24	30	23	19	21	21	24	20	23	22	27	29	32	37	33
1 - Sum af EBVfat_ped	11	15	21	18	16	18	19	23	19	22	22	27	29	32	37	33
1 - Sum af GEBVfat	16	20	24	21	17	19	19	24	22	26	26	32	35	39	48	47
1 - Sum af GEBVfat_ped	10	14	19	16	15	17	18	22	20	23	23	28	32	36	44	42

Figure 15 EBV and GEBV trend vs pedigree trend for fat combined (1-3 lact) for females with own records.



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
0 - Sum af EBVfat	-29	-24	-21	-18	-12	-9	-5	-2	2	5	10	12	15	17	20	23	29	37	28		
0 - Sum af EBVfat_ped	-29	-24	-21	-18	-12	-9	-5	-2	2	5	10	12	15	17	21	24	29	37	28		
0 - Sum af GEBVfat	-29	-24	-20	-18	-12	-9	-5	-2	2	5	10	12	16	18	22	26	34	48	41		
0 - Sum af GEBVfat_ped	-29	-24	-20	-18	-12	-9	-5	-2	1	5	10	12	16	18	22	26	32	44	38		
1 - Sum af EBVfat					31	9	17	11	22	20	22	22	26	22	27	28	31	35	35	43	44
1 - Sum af EBVfat_ped					29	13	16	11	21	19	22	22	26	22	27	28	31	35	35	43	44
1 - Sum af GEBVfat					46	10	15	22	17	19	20	22	27	24	30	32	37	44	50	66	72
1 - Sum af GEBVfat_ped					21	11	13	14	19	18	21	21	26	23	28	30	35	41	46	59	65

Figure 16 EBV and GEBV trend vs pedigree trend for fat combined (1-3 lact) for females without own records.

If we look at the genotyped animals, it is seen that for animals without production records (Figure 12, Figure 14 and Figure 16) the level of the GEBV is higher than the pedigree index based on GEBV in especially the later years. It should however be noticed from Figure 12 that in the yearclasses from 2004-2011 for genotyped females without production records, there are only a limited number of animals (1-265 obs per year class).

For genotyped females with and without own performance records, the average GEBV per year class is in gereal higher than average pedigree index based on parenst GEBVs. In the later yearclasses, where the EBV and pedigree index based on parents EBVs are at the same level, these results are highly unexpected and not easy to give a reasonable explanation for.

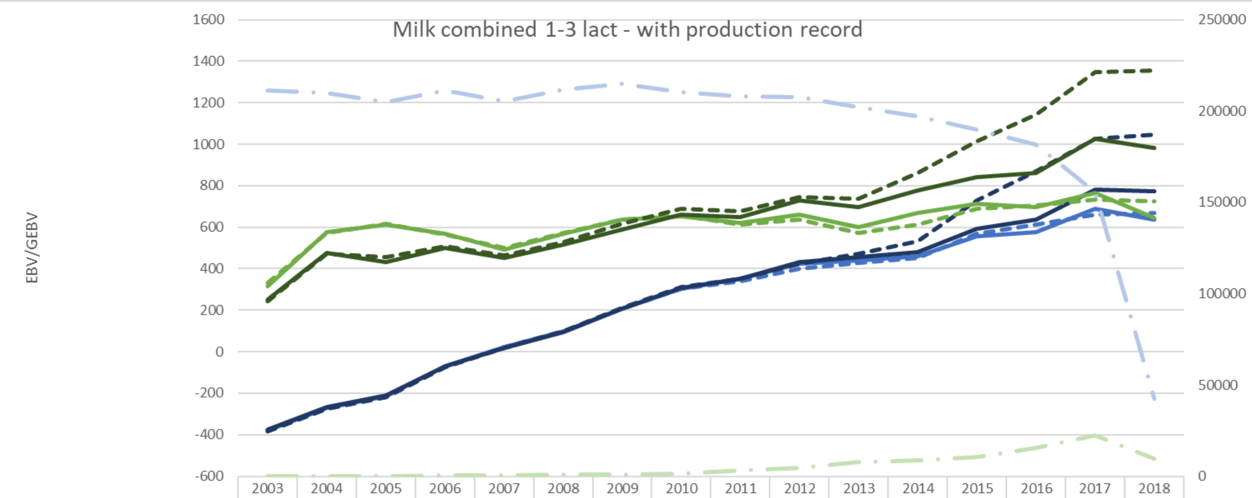
Full and reduced data EBV/GEBV

In Figure 17 to Figure 22 trends for full vs reduced models are shown for females with (Figure 17, Figure 19 and Figure 21) and without (Figure 18, Figure 20 and Figure 22) own production records, respectively. Green coloured lines are for genotyped animals, whereas blue lines are results for non-genotyped animals. Darker colours are GEBVs while brighter colours are EBVs. Finally, broken lines are showing results from the reduced evaluation, where 4 years of phenotypic data are cut of, and full lines are from the full dataset with all phenotypic data included. In Figure 17 and Figure 18 the number of observations can also be seen for genotyped and non-genotyped animals.

In Figure 17 and Figure 18 we see that for the EBVs (brighter colored lines) that full and reduced data are following each other pretty closely for milk yield. This was perhaps not expected for the later year classes, as we would expect that the sires of these animals are selected based on a GEBV and thus expected to have a positive mendelian sampling term. Therefor we would also expect that the full lines should be at a little higher level than the broken lines, as there should be data available showning this selection path. An explenation why we actually do not see a difference could be, that there is actually not much selection for milk yiled, as this is weighted negatively in the yild index. For protein yield (Figure 19 and Figure 20) we se as expected that the trend from the full evaluation is higher than for the reduced evaluation for the later birth year classes, whereas for fat yield (Figure 21 and Figure 22) we se only a slight increase in trend in the full evaluation.

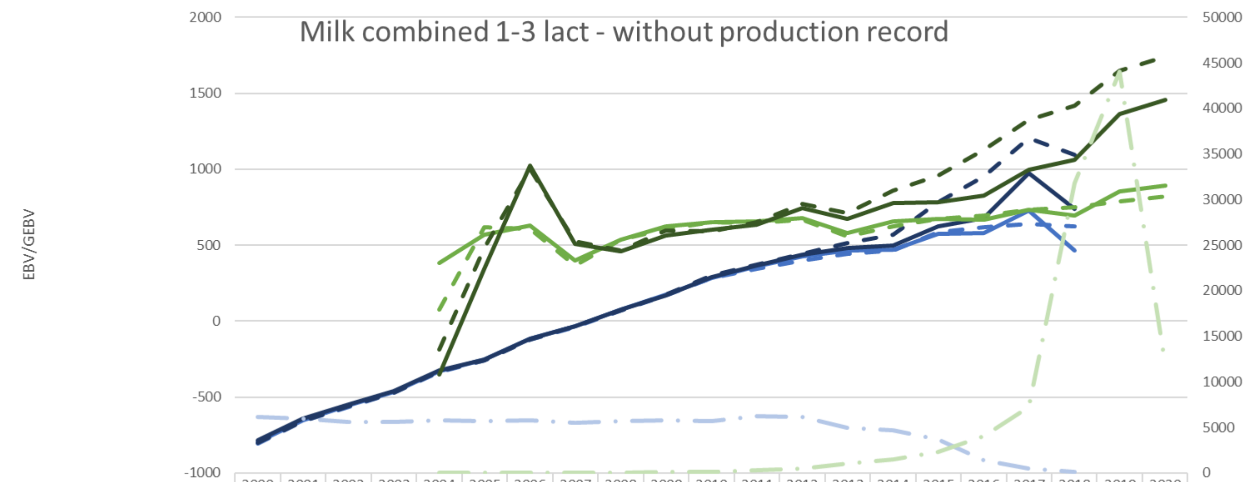
For the GEBVs we would however expect that the full and the reduced run follows similar trend, as the selection made on young genotyped sires is acconted for. This is seen for all three yield traits and for

genotyped and non-genotyped animals with and without own production records. It can se seen for birthyear classes 2019 and 2020 (genotyped females without own production records) that the difference between the full and the reduced runs seem to decrease compared to birthyear classes 2017 and 2018. This might also be related to phenomenon seen in Figure 11 - Figure 16, where it was seen that genotyped animals without own perfomance records on avaerage had a higher GEBV than what was epected from the pedigree.
In conclusion there seems to be some challenges with both the traditional EBVs that do not account for the selection on genotypic information and the SS GEBVs where the trend in the reduced data seems to be overestimated as well as genotyped non selected animals tend to have on average a higher level than the parent average which is not logical.



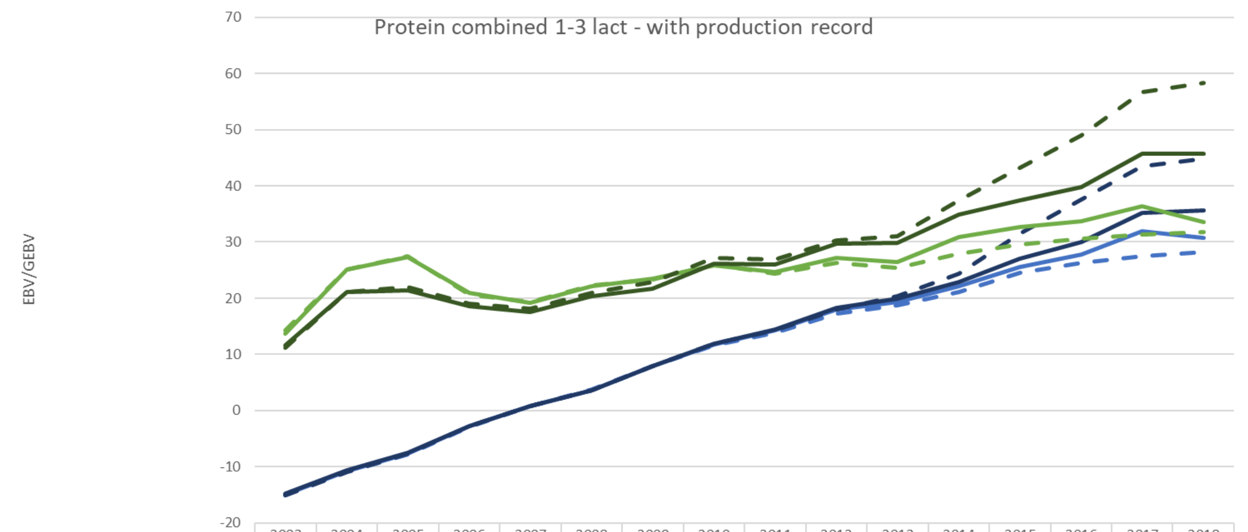
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
0 - Sum af EBVmilk	-378	-270	-215	-72	21	98	209	305	350	424	441	458	555	578	690	638
0 - Sum af EBVredmilk	-383	-275	-218	-73	21	99	209	304	338	400	426	451	570	613	660	670
0 - Sum af GEBVmilk	-374	-268	-212	-70	20	96	206	307	353	430	454	481	593	635	780	774
0 - Sum af GEBVredmilk	-383	-275	-217	-73	20	98	210	312	352	422	471	533	731	870	1025	1046
1 - Sum af EBVmilk	316	575	612	569	493	570	638	652	622	663	602	670	713	698	765	644
1 - Sum af EBVredmilk	333	574	616	563	499	573	636	658	611	638	572	614	690	704	732	725
1 - Sum af GEBVmilk	250	477	432	502	451	516	589	660	649	730	698	778	840	862	1026	983
1 - Sum af GEBVredmilk	243	471	455	509	466	527	615	688	677	747	737	862	1014	1143	1346	1355
0 - Sum af _FREQ_	211124	209923	204706	211413	205480	211496	214790	210303	208074	207508	201927	197198	189790	181400	155447	42246
1 - Sum af _FREQ_	24	121	205	352	449	767	1119	1565	3094	4770	7750	8799	10523	15579	22257	9621

Figure 17 Full and reduced EBV/GEBV trend for milk combined (1-3 lact) for females with own production records.



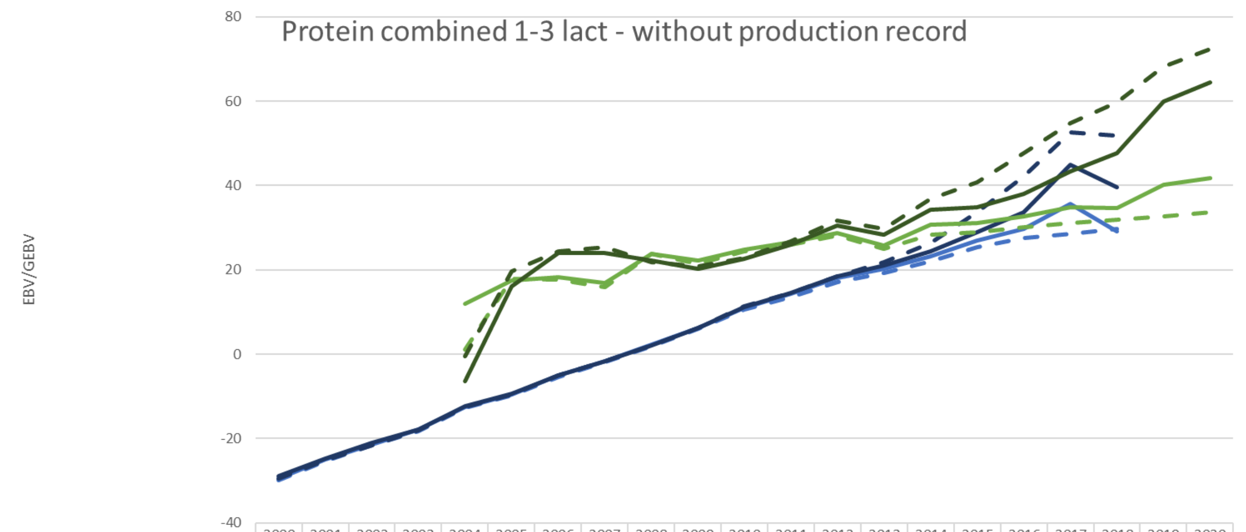
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
0 - Sum af EBVmilk	-797	-651	-555	-464	-328	-253	-118	-36	77	173	286	362	427	466	471	573	580	726	464		
0 - Sum af EBVredmilk	-807	-660	-564	-472	-336	-260	-124	-39	69	168	281	345	400	446	463	588	617	639	624		
0 - Sum af GEBVmilk	-783	-642	-548	-459	-324	-251	-116	-36	74	170	289	363	439	483	499	625	679	974	739		
0 - Sum af GEBVredmilk	-799	-657	-560	-471	-331	-256	-119	-36	72	173	300	371	440	512	568	781	950	1204	1094		
1 - Sum af EBVmilk					385	569	629	401	534	623	652	657	678	581	659	672	669	733	695	855	893
1 - Sum af EBVredmilk					76	618	608	368	537	609	652	644	665	558	623	671	696	732	749	788	821
1 - Sum af GEBVmilk					-349	343	1024	507	461	566	600	636	742	671	776	785	829	998	1061	1363	1458
1 - Sum af GEBVredmilk					-190	483	1001	527	467	598	590	651	770	710	858	958	1125	1324	1418	1646	1741
0 - Sum af _FREQ_	6172	5943	5612	5583	5818	5726	5758	5532	5695	5765	5719	6264	6103	4941	4656	3658	1390	456	145		
1 - Sum af _FREQ_					1	8	10	9	34	86	134	265	498	1064	1452	2300	4038	7264	31786	44051	11802

Figure 18 Full and reduced EBV/GEBV trend for milk combined (1-3 lact) for females without own production records.



	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
0 - Sum af EBVprotein	-15	-11	-8	-3	1	4	8	12	14	18	19	22	26	28	32	31
0 - Sum af EBVredprotein	-15	-11	-8	-3	1	4	8	12	14	17	19	21	24	26	27	28
0 - Sum af GEBVprotein	-15	-11	-7	-3	1	4	8	12	14	18	20	23	27	30	35	36
0 - Sum af GEBVredprotein	-15	-11	-8	-3	1	4	8	12	14	18	20	24	31	38	43	45
1 - Sum af EBVprotein	14	25	27	21	19	22	23	26	25	27	26	31	33	34	36	34
1 - Sum af EBVredprotein	14	25	27	21	19	22	23	26	24	26	25	28	30	31	31	32
1 - Sum af GEBVprotein	12	21	21	19	18	20	22	26	26	30	30	35	37	40	46	46
1 - Sum af GEBVredprotein	11	21	22	19	18	21	23	27	27	30	31	37	43	49	57	58

Figure 19 Full and reduced EBV/GEBV trend for protein combined (1-3 lact) for females with own production records.

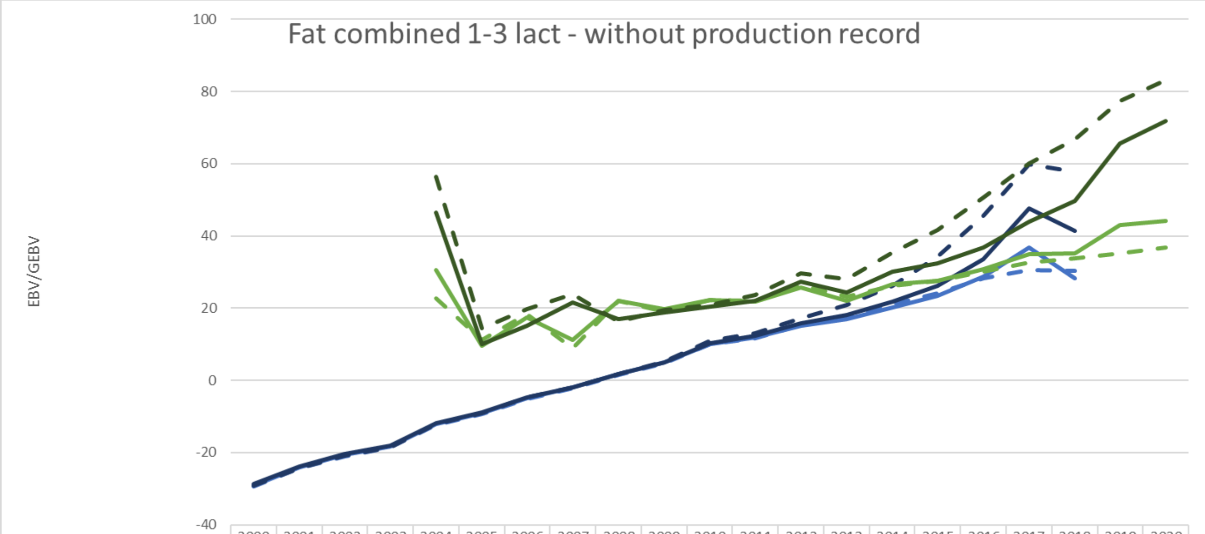


	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
0 - Sum af EBVprotein	-30	-25	-21	-18	-13	-10	-5	-2	2	6	11	14	18	20	23	27	30	36	29		
0 - Sum af EBVredprotein	-30	-25	-22	-18	-13	-10	-5	-2	2	6	11	14	17	19	22	25	28	28	30		
0 - Sum af GEBVprotein	-29	-25	-21	-18	-12	-9	-5	-2	2	6	11	15	19	21	24	29	34	45	40		
0 - Sum af GEBVredprotein	-30	-25	-22	-18	-13	-10	-5	-2	2	6	11	15	19	22	26	34	42	53	52		
1 - Sum af EBVprotein					12	18	18	17	24	22	25	27	29	26	31	31	33	35	35	40	42
1 - Sum af EBVredprotein					1	18	18	16	24	21	24	26	28	25	28	29	30	31	32	33	34
1 - Sum af GEBVprotein					-6	16	24	24	22	20	23	26	31	28	34	35	38	43	48	60	64
1 - Sum af GEBVredprotein					0	20	24	25	22	21	23	27	32	30	37	41	48	55	60	68	72

Figure 20 Full and reduced EBV/GEBV trend for protein combined (1-3 lact) for females without own production records.

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
0 - Sum af EBVfat	-14	-9	-6	-2	1	3	6	11	12	15	16	19	22	26	32	30
0 - Sum af EBVredfat	-14	-10	-6	-2	1	3	6	11	12	15	17	20	23	26	29	30
0 - Sum af GEBVfat	-14	-9	-6	-2	1	3	6	11	12	15	17	20	24	29	37	36
0 - Sum af GEBVredfat	-14	-10	-6	-2	1	3	6	11	12	16	18	24	31	40	49	50
1 - Sum af EBVfat	20	24	30	23	19	21	21	24	20	23	22	27	29	32	37	33
1 - Sum af EBVredfat	20	24	30	23	19	21	21	24	20	23	23	26	28	30	33	34
1 - Sum af GEBVfat	16	20	24	21	17	19	19	24	22	26	26	32	35	39	48	47
1 - Sum af GEBVredfat	16	21	25	21	17	20	20	26	24	28	30	37	44	52	64	65

Figure 21 Full and reduced EBV/GEBV trend for fat combined (1-3 lact) for females with own production records.



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
0 - Sum af EBVfat	-29	-24	-21	-18	-12	-9	-5	-2	2	5	10	12	15	17	20	23	29	37	28		
0 - Sum af EBVredfat	-29	-24	-21	-18	-12	-9	-5	-2	2	5	10	12	15	18	21	24	28	31	30		
0 - Sum af GEBVfat	-29	-24	-20	-18	-12	-9	-5	-2	2	5	10	12	16	18	22	26	34	48	41		
0 - Sum af GEBVredfat	-29	-24	-21	-18	-12	-9	-5	-2	2	5	11	13	17	21	26	34	46	60	58		
1 - Sum af EBVfat					31	9	17	11	22	20	22	22	26	22	27	28	31	35	35	43	44
1 - Sum af EBVredfat					23	11	18	9	22	19	22	22	26	23	26	28	30	33	34	35	37
1 - Sum af GEBVfat					46	10	15	22	17	19	20	22	27	24	30	32	37	44	50	66	72
1 - Sum af GEBVredfat					56	14	20	24	16	19	21	24	30	28	36	42	51	60	67	77	83

Figure 22 Full and reduced EBV/GEBV trend for fat combined (1-3 lact) for females without own production records.

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Appendix 1

Birth year	milk-index1	milk-index2	milk-index3	protein-index1	protein-index2	protein-index3	fat-index1	fat-index2	fat-index3	N_obs
1970	0,992	0,99	0,995	0,994	0,994	0,996	0,995	0,996	0,997	12331
1971	0,994	0,992	0,996	0,995	0,995	0,997	0,996	0,996	0,997	15100
1972	0,992	0,991	0,996	0,994	0,994	0,997	0,995	0,996	0,997	19695
1973	0,992	0,99	0,995	0,994	0,994	0,997	0,995	0,996	0,997	24697
1974	0,992	0,989	0,995	0,994	0,994	0,997	0,995	0,995	0,997	31664
1975	0,989	0,987	0,993	0,991	0,991	0,995	0,993	0,994	0,995	39959
1976	0,99	0,988	0,993	0,991	0,991	0,995	0,993	0,994	0,995	50429
1977	0,991	0,988	0,993	0,991	0,991	0,994	0,993	0,994	0,995	57459
1978	0,991	0,989	0,993	0,991	0,991	0,994	0,993	0,994	0,995	66063
1979	0,992	0,991	0,994	0,992	0,992	0,995	0,994	0,995	0,996	77165
1980	0,991	0,991	0,993	0,991	0,991	0,994	0,993	0,994	0,995	91010
1981	0,992	0,991	0,994	0,991	0,991	0,994	0,993	0,995	0,996	104380
1982	0,992	0,992	0,994	0,991	0,991	0,994	0,994	0,995	0,996	116080
1983	0,993	0,993	0,994	0,991	0,992	0,995	0,994	0,995	0,996	134202
1984	0,994	0,994	0,995	0,992	0,993	0,995	0,995	0,996	0,997	149256
1985	0,994	0,995	0,996	0,993	0,994	0,996	0,995	0,997	0,997	167358
1986	0,995	0,996	0,997	0,994	0,995	0,997	0,996	0,997	0,998	208471
1987	0,996	0,996	0,998	0,995	0,996	0,997	0,996	0,998	0,998	234793
1988	0,997	0,997	0,998	0,996	0,997	0,998	0,997	0,998	0,999	279318
1989	0,997	0,998	0,999	0,997	0,997	0,998	0,998	0,998	0,999	286411
1990	0,998	0,998	0,999	0,997	0,998	0,999	0,998	0,999	0,999	292609
1991	0,998	0,998	0,999	0,997	0,998	0,999	0,998	0,999	0,999	293396
1992	0,998	0,998	0,999	0,997	0,998	0,999	0,998	0,999	0,999	301840
1993	0,998	0,998	0,999	0,997	0,998	0,999	0,998	0,999	0,999	319909
1994	0,998	0,999	0,999	0,997	0,998	0,999	0,998	0,999	0,999	332578
1995	0,998	0,999	0,999	0,998	0,998	0,999	0,998	0,999	1	337559
1996	0,998	0,999	0,999	0,998	0,998	0,999	0,998	0,999	0,999	335359
1997	0,999	0,999	0,999	0,998	0,999	0,999	0,998	0,999	0,999	335079
1998	0,999	0,999	0,999	0,998	0,999	0,999	0,999	0,999	1	333352
1999	0,999	0,999	0,999	0,998	0,999	0,999	0,999	0,999	1	327067
2000	0,999	0,999	0,999	0,998	0,999	0,999	0,999	0,999	1	319562
2001	0,999	0,999	0,999	0,999	0,999	0,999	0,999	0,999	1	318617
2002	0,999	0,999	1	0,999	0,999	0,999	0,999	0,999	1	309309
2003	0,999	1	1	0,999	0,999	0,999	0,999	1	1	303644
2004	0,999	0,999	1	0,999	0,999	0,999	0,999	1	1	298597
2005	0,999	1	1	0,999	0,999	0,999	0,999	1	1	289210
2006	0,999	1	1	0,999	0,999	0,999	0,999	1	1	294672
2007	0,999	1	1	0,999	0,999	1	0,999	1	1	285702
2008	0,999	1	1	0,999	1	1	0,999	1	1	290592
2009	0,999	1	1	0,999	1	1	0,999	1	1	291923
2010	0,999	1	1	0,999	0,999	1	0,999	1	1	283579
2011	0,999	1	1	0,999	0,999	1	0,999	1	1	282612
2012	0,999	1	1	0,999	1	1	0,999	1	1	278269
2013	0,999	1	1	0,999	0,999	1	0,999	1	1	269923
2014	0,999	1	1	0,999	1	1	0,999	1	1	261369

2015	0,999	1	1	0,999	1	1	0,999	1	1	248626
2016	0,999	1	1	0,999	1	1	0,999	1	1	237498
2017	0,999	1	0,999	0,999	0,999	0,999	0,999	0,999	0,999	212047
2018	0,998	0,996	0,994	0,997	0,996	0,994	0,998	0,997	0,996	60075
2019	1	1	1	1	1	1	1	1	1	3

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Appendix 2

Birth year	milk-index1	milk-index2	milk-index3	protein-index1	protein-index2	protein-index3	fat-index1	fat-index2	fat-index3	N_obs
1970	1	1	1	1	1	1	1	1	1	2
1971	1	1	1	1	1	1	1	1	1	2
1972	0,995	0,998	0,998	0,993	0,997	0,997	0,994	0,998	0,999	7
1973	0,996	0,998	0,998	0,994	0,996	0,997	0,994	0,996	0,997	16
1974	0,997	0,998	0,999	0,996	0,998	0,999	0,996	0,997	0,998	18
1975	0,99	0,994	0,996	0,987	0,991	0,994	0,992	0,996	0,997	41
1976	0,987	0,995	0,997	0,975	0,986	0,99	0,986	0,995	0,997	26
1977	0,996	0,997	0,998	0,993	0,995	0,997	0,994	0,997	0,998	62
1978	0,998	0,998	0,999	0,997	0,997	0,999	0,998	0,999	0,999	66
1979	0,996	0,998	0,999	0,995	0,997	0,998	0,997	0,998	0,999	63
1980	0,998	0,999	0,999	0,998	0,998	0,999	0,998	0,998	0,999	104
1981	0,998	0,999	0,999	0,998	0,998	0,999	0,998	0,999	0,999	147
1982	0,997	0,998	0,999	0,996	0,998	0,998	0,996	0,998	0,999	193
1983	0,998	0,998	0,999	0,997	0,998	0,999	0,998	0,999	0,999	254
1984	0,998	0,999	0,999	0,998	0,998	0,999	0,998	0,999	0,999	406
1985	0,998	0,999	0,999	0,998	0,998	0,999	0,998	0,999	1	918
1986	0,999	0,999	0,999	0,998	0,999	0,999	0,999	0,999	1	1111
1987	0,999	0,999	0,999	0,998	0,999	0,999	0,999	0,999	1	1017
1988	0,998	0,999	0,999	0,997	0,998	0,999	0,998	0,999	0,999	1204
1989	0,998	0,999	0,999	0,998	0,998	0,999	0,998	0,999	0,999	1159
1990	0,999	0,999	0,999	0,998	0,999	0,999	0,999	0,999	1	1208
1991	0,998	0,999	0,999	0,998	0,998	0,999	0,998	0,999	0,999	1422
1992	0,999	0,999	0,999	0,999	0,999	0,999	0,999	0,999	1	1519
1993	0,998	0,999	0,999	0,997	0,998	0,999	0,998	0,999	0,999	1351
1994	0,998	0,999	0,999	0,998	0,999	0,999	0,998	0,999	0,999	1354
1995	0,998	0,999	0,999	0,998	0,998	0,999	0,998	0,999	0,999	1429
1996	0,998	0,999	0,999	0,998	0,999	0,999	0,998	0,999	0,999	1335
1997	0,998	0,999	0,999	0,998	0,999	0,999	0,999	0,999	0,999	1450
1998	0,998	0,999	0,999	0,997	0,998	0,998	0,998	0,999	0,999	1393
1999	0,998	0,999	0,999	0,998	0,998	0,999	0,998	0,999	0,999	1323
2000	0,997	0,998	0,998	0,997	0,998	0,998	0,997	0,998	0,998	3832
2001	0,997	0,998	0,998	0,996	0,997	0,998	0,997	0,998	0,998	3998
2002	0,997	0,998	0,998	0,997	0,997	0,998	0,997	0,998	0,998	3693
2003	0,998	0,998	0,998	0,997	0,998	0,998	0,997	0,998	0,998	3445
2004	0,997	0,998	0,998	0,997	0,998	0,998	0,997	0,998	0,998	3351
2005	0,997	0,998	0,998	0,997	0,998	0,998	0,997	0,998	0,998	3140
2006	0,997	0,998	0,998	0,996	0,997	0,998	0,997	0,998	0,998	2968
2007	0,998	0,999	0,999	0,997	0,998	0,998	0,998	0,998	0,999	2773
2008	0,996	0,997	0,997	0,995	0,997	0,997	0,996	0,997	0,998	2655
2009	0,995	0,997	0,997	0,994	0,996	0,996	0,995	0,997	0,997	2492
2010	0,993	0,995	0,996	0,992	0,994	0,995	0,993	0,996	0,996	2431
2011	0,992	0,995	0,996	0,991	0,994	0,995	0,992	0,995	0,996	2201
2012	0,988	0,992	0,993	0,987	0,991	0,992	0,989	0,993	0,994	2081
2013	0,987	0,992	0,992	0,985	0,99	0,991	0,988	0,993	0,994	1856
2014	0,993	0,996	0,996	0,992	0,995	0,995	0,993	0,996	0,997	1581

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2015	0,996	0,997	0,997	0,995	0,996	0,996	0,995	0,997	0,997	1191
2016	0,994	0,996	0,996	0,992	0,994	0,995	0,993	0,996	0,996	357
2017										1

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