



World Inbreeding Trend in Holsteins

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World Holstein Friesian Federation 2020

WHFF–Council decision

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- ▶ The inbreeding calculation standard of WHFF was set by a TF group in 2015 (B. Van Doormaal, G. De Jong, St. Rensing)
- ▶ FAO recommendation: The inbreeding should not be higher than **1% per generation** (=4 yrs)
- ▶ Questionnaire will be send out to the members **every four years**
- ▶ Inbreeding should be recorded from **→1980**
- ▶ To report about the result at every General Assembly
- ▶ Due to the Corona crisis in 2020 this report is send out to the members and publish at the WHFF website.



What is Inbreeding?

- ▶ **Inbreeding** is the mating of individuals that are related by ancestry and result in a reduction of heterozygosity within a population. It can lead to a reduced biological fitness.
- ▶ The **inbreeding coefficient (F)** is a measure of inbreeding. It can be defined as both
 - the probability that two alleles at any given locus are identical by descent and
 - the probable proportion of an individual's loci containing genes that are identical by descent
- ▶ **Inbreeding depression (IBD)** is the effect of inbreeding measured as the reduction in mean phenotypic performance with increasing levels of inbreeding within a population



What level of inbreeding is acceptable

- ▶ There is no defined limit what an acceptable level of inbreeding, in domestic animal populations, should be.
- ▶ It was defined by FAO that inbreeding should not be higher than 1% per generation



How to compare Inbreeding

- ▶ The **absolute value** of the inbreeding factor depends very much on the completeness of the pedigrees
 - different in many countries
 - not a good comparison
- ▶ More informative and better directly comparable as the absolute value of inbreeding is the “**rate of change in inbreeding over a time period**”
- ▶ The results of the change of inbreeding will be very **similar in the different calculation methods**
- ▶ **Final Comparison:**
 - how is the **change of the inbreeding rate per year** and
 - how has the average inbreeding rate **changed over a period of 10 years**



Data collection requirements

- ▶ The inbreeding coefficients has been calculated with the data in each domestic population
 - ▶ Females born from 1980 until 2019 (the current birth date of the calves)
 - ▶ Calculation only on the domestic females with at least 87% Holstein blood
- ➡ 26 countries participated with data in the survey
(18 countries in 2015)



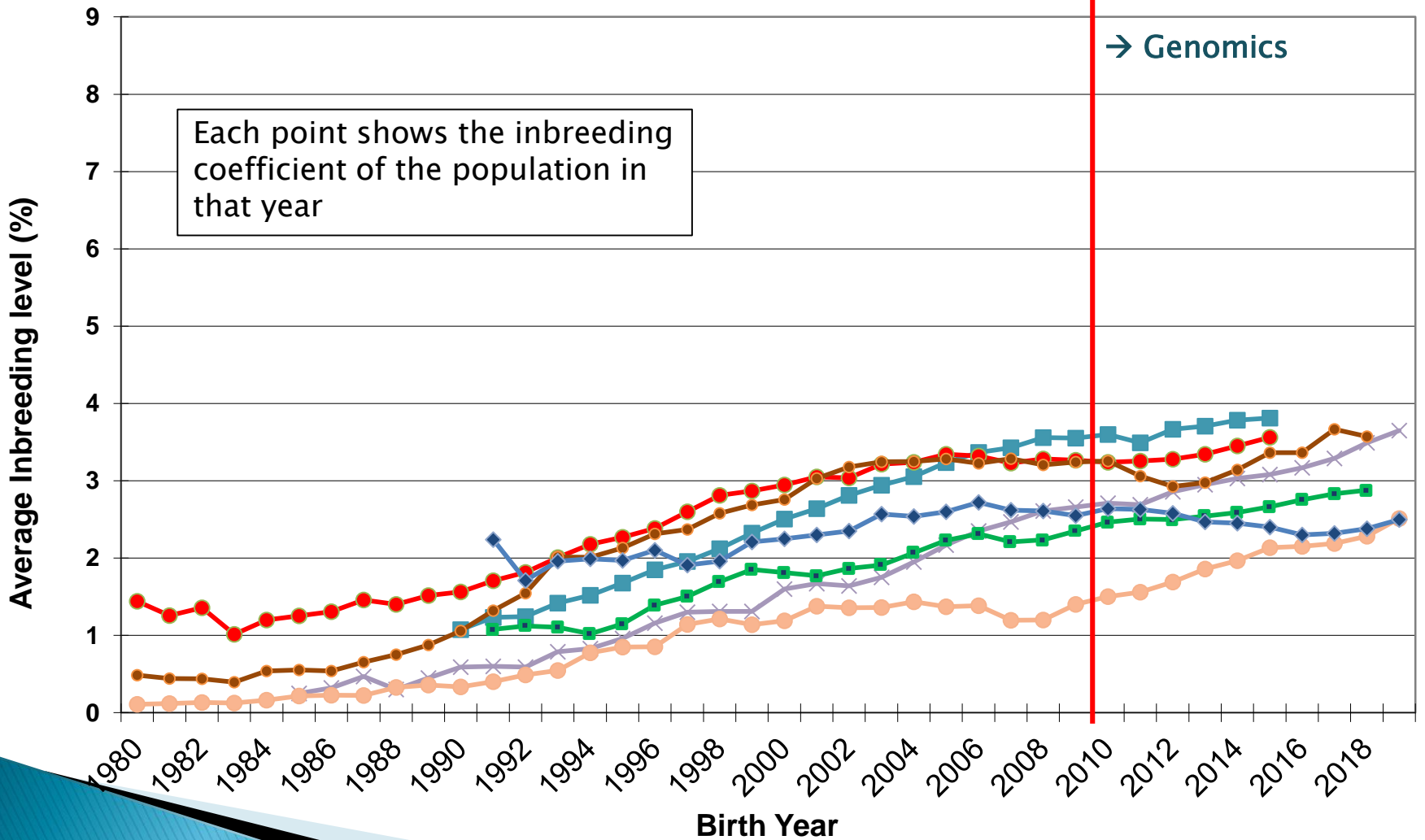
Different calculation methods

The 26 countries had different calculation methods:

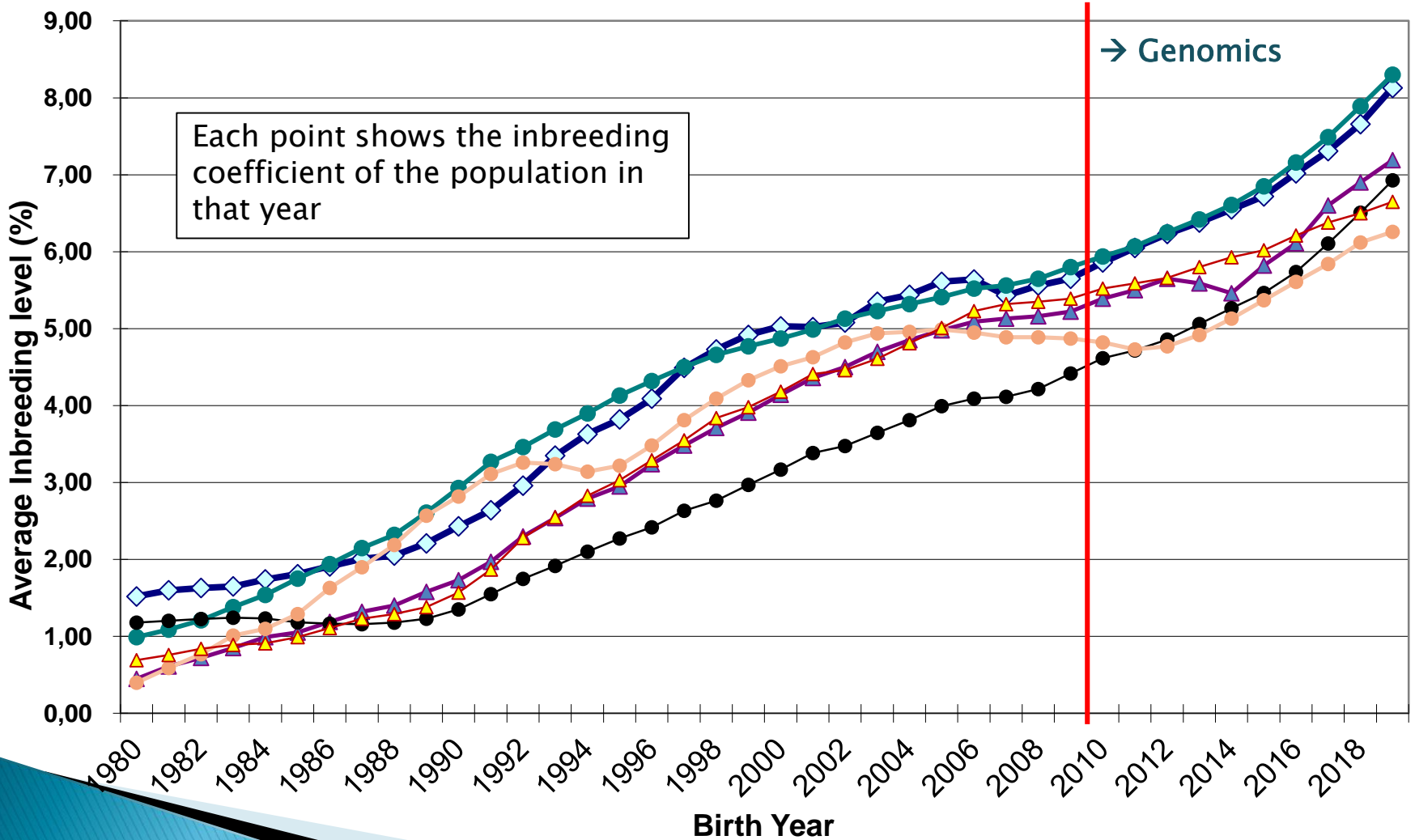
- ▶ Meuwissen and Luo, 1992 (9)
- ▶ VanRaden, 1992 (7) and similar to VanRaden (3)
- ▶ Wright inbreeding coefficient, 1920 (3)
- ▶ Aguilar and Misztal, 2008 (2)
- ▶ Others (2)

➡ It doesn't affect the results since the change of the inbreeding within each country is calculated.

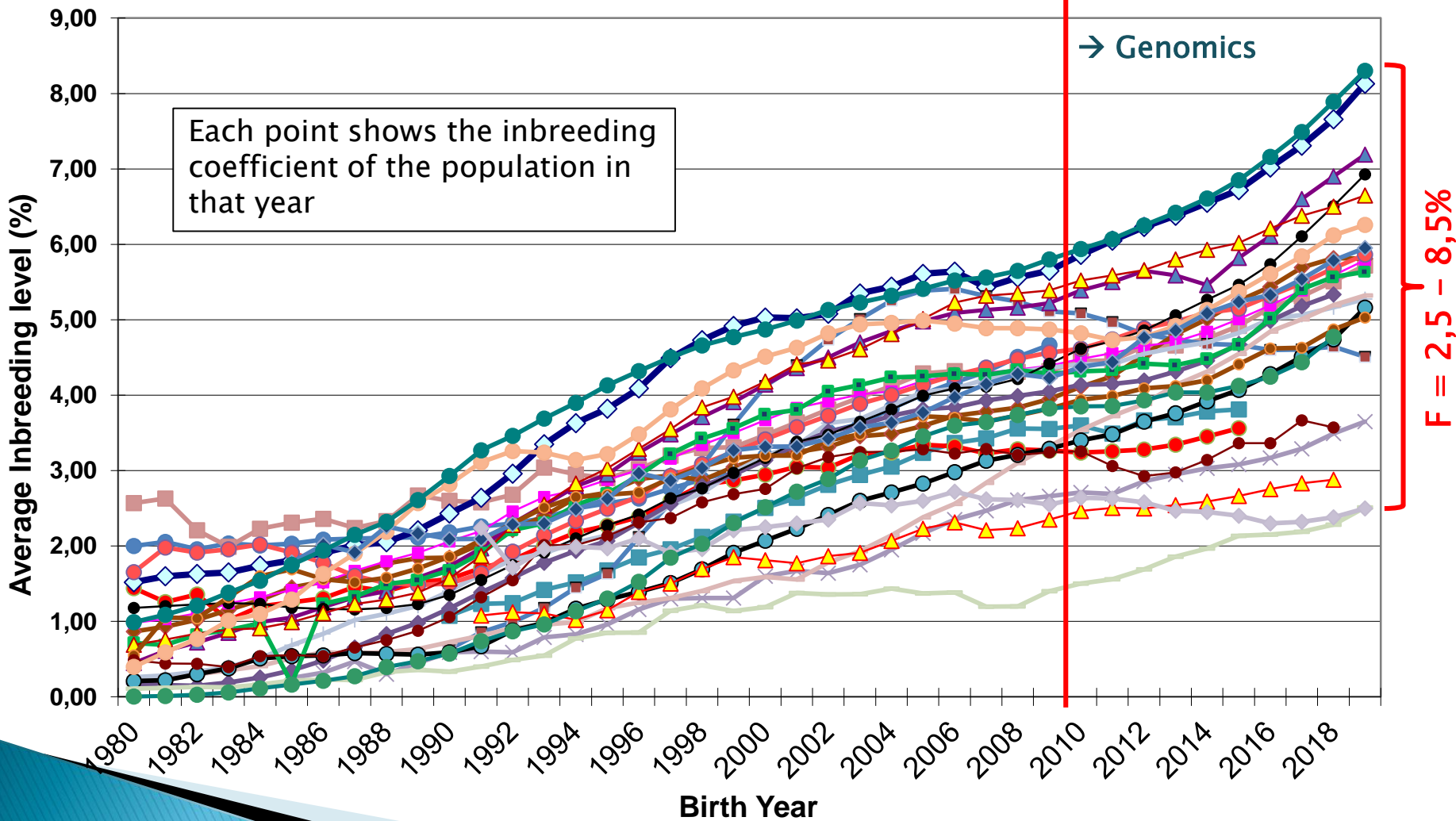
Countries with negligible inbreeding trends



Countries with clear inbreeding trends



Inbreeding trend in 26 countries



Average increase in inbreeding per year



Birth Year	1980 to 1990	1990 to 2000	2000 to 2010	2010 to 2019
ITA	0,02	0,18	0,14	0,26
USA	0,19	0,19	0,11	0,26
CAN	0,09	0,26	0,08	0,25
FIN	0,06	0,09	0,19	0,20
POL	0,02	0,10	0,16	0,20
HUN	0,04	0,15	0,13	0,20
ESP	0,13	0,24	0,13	0,20
CHE	0,10	0,13	0,09	0,19
SLO	0,06	0,12	0,11	0,18
NLD	0,24	0,17	0,03	0,16
FRA	0,10	0,20	0,10	0,16
DEU	0,11	0,16	0,08	0,15
IRL	0,10	0,21	0,06	0,15
GBR	-0,02	0,19	0,12	0,14
AUT	0,00	0,09	0,10	0,14
JPN	0,09	0,26	0,13	0,13
SWE	0,06	0,19	0,13	0,12
LUX	0,13	0,13	0,07	0,12
NZL	0,02	0,09	0,03	0,11
DNK	0,11	0,18	0,12	0,10
EST	0,07	0,10	0,11	0,10
BEL (Wallony)	0,01	0,14	0,03	0,06
ISR		0,08	0,07	0,05
AUS		0,14	0,11	0,04
MEX	0,06	0,17	0,05	0,04
SVK		0,00	0,04	-0,02
CZE		0,35	0,10	-0,06

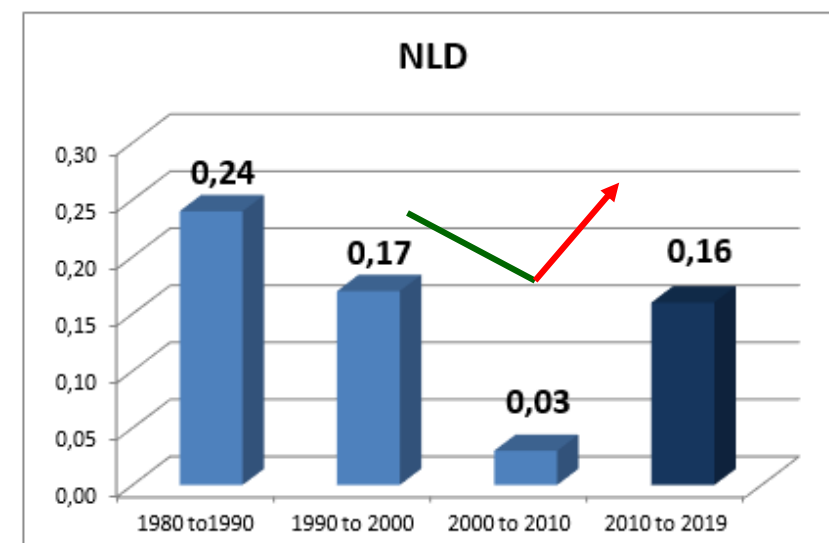
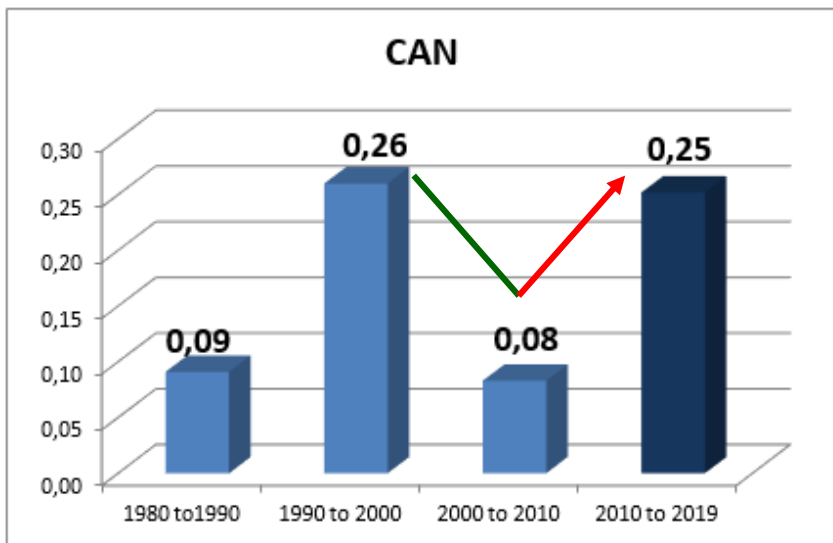
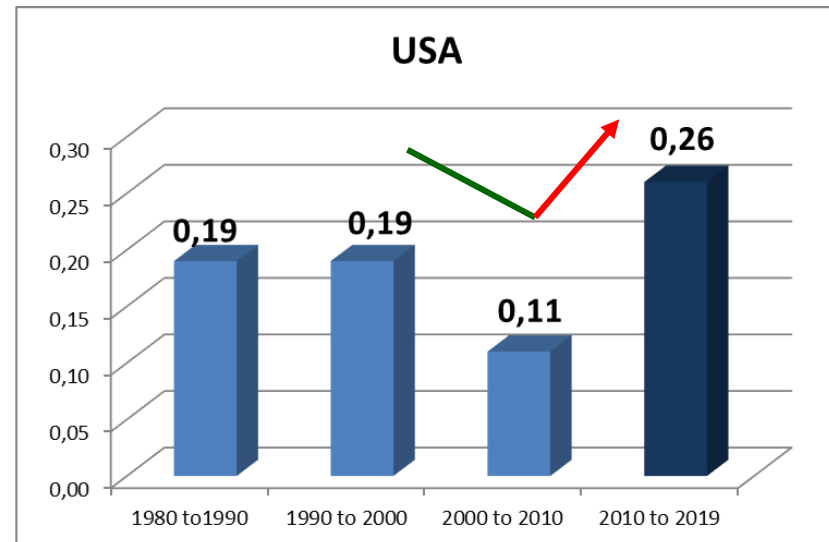
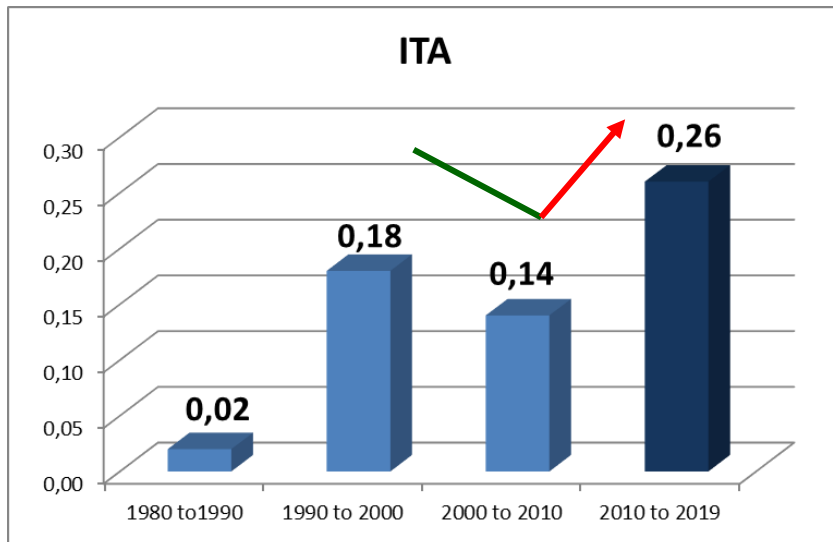
difficult

moderate

Genes from
?? a different
?? population

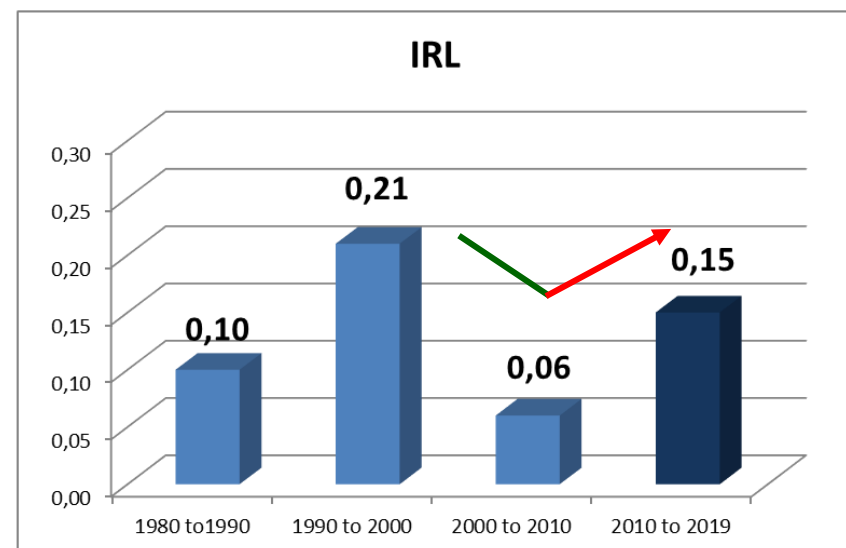
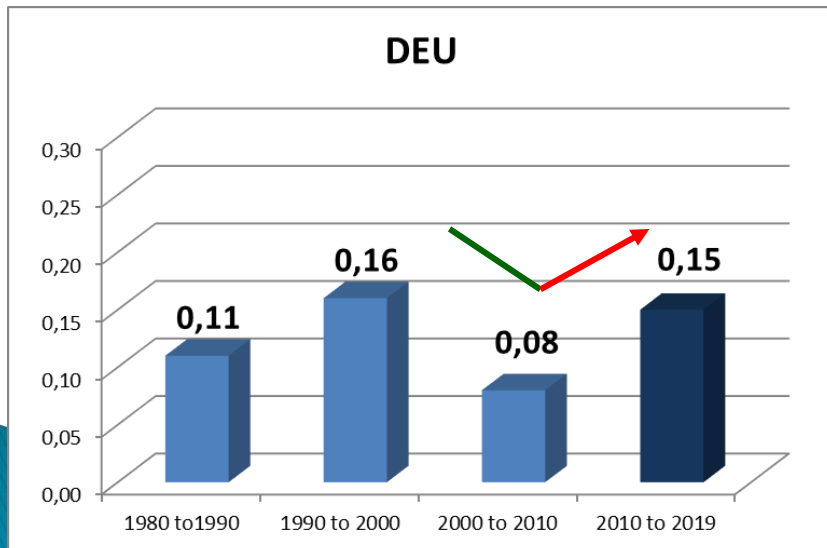
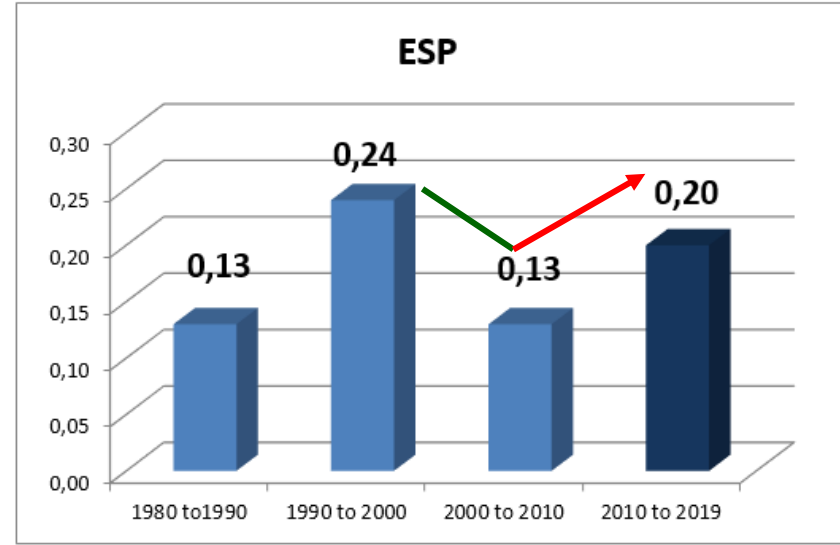
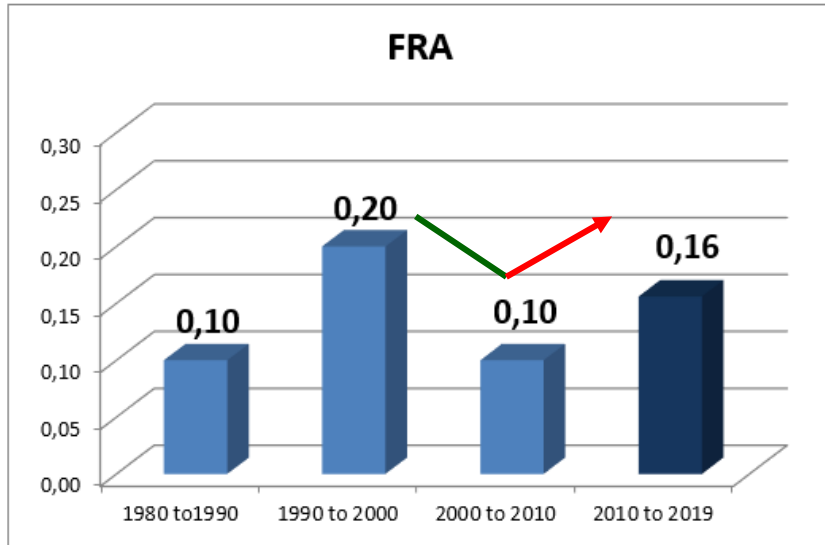


Average increase in inbreeding per year (The rate of inbreeding shows a clear upward trend)

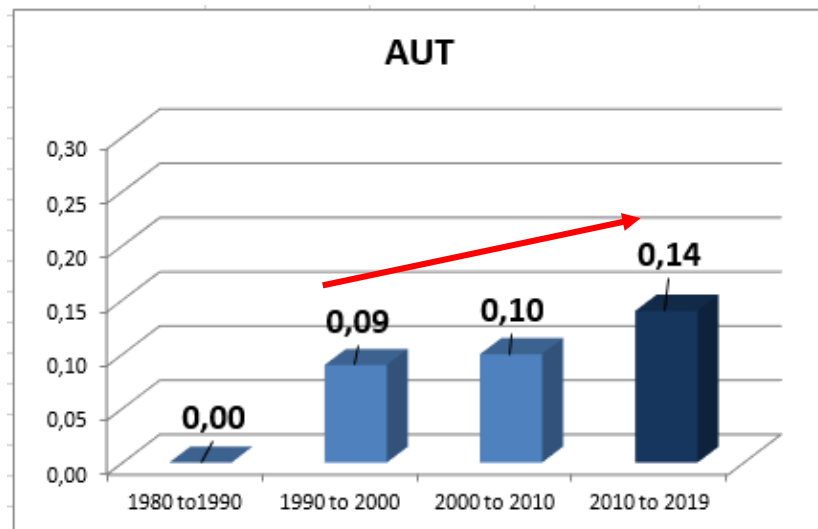
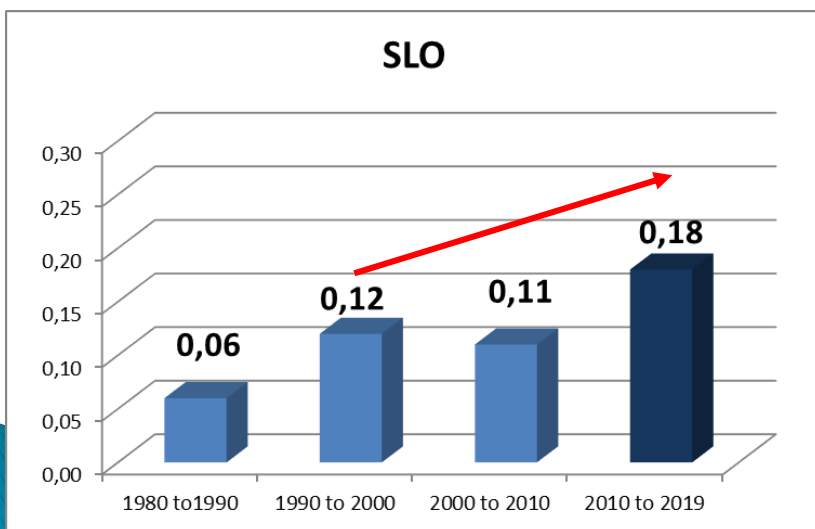
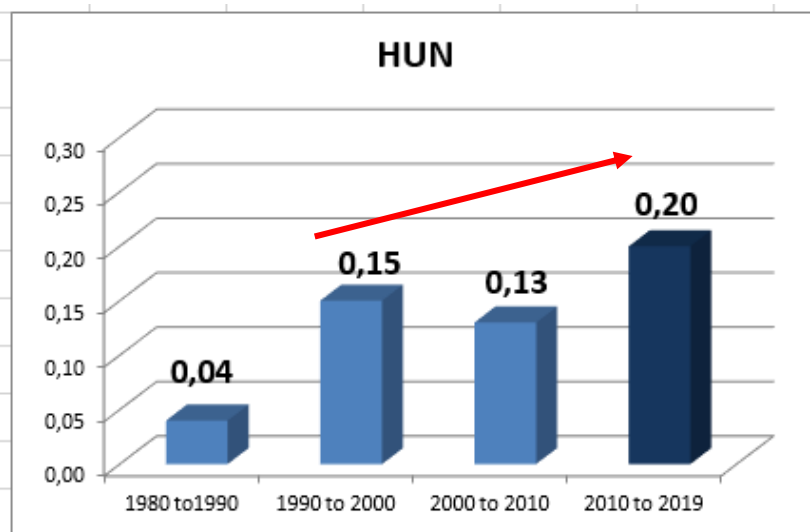
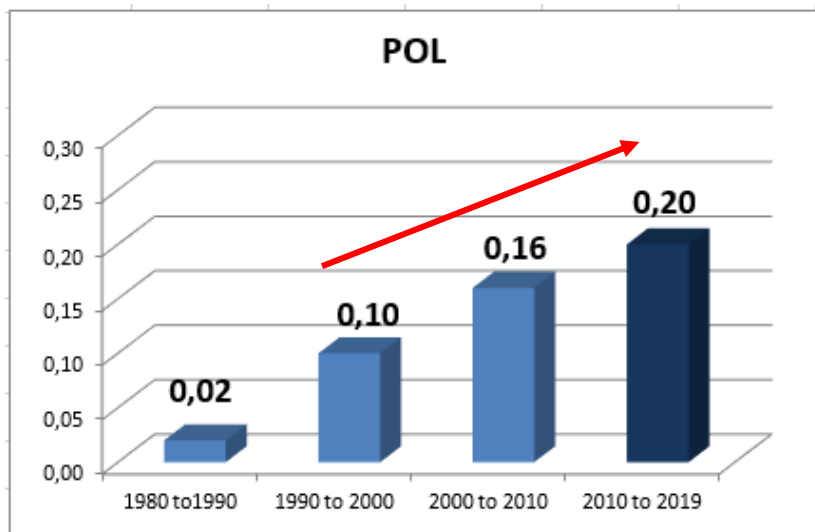


Average increase in inbreeding per year

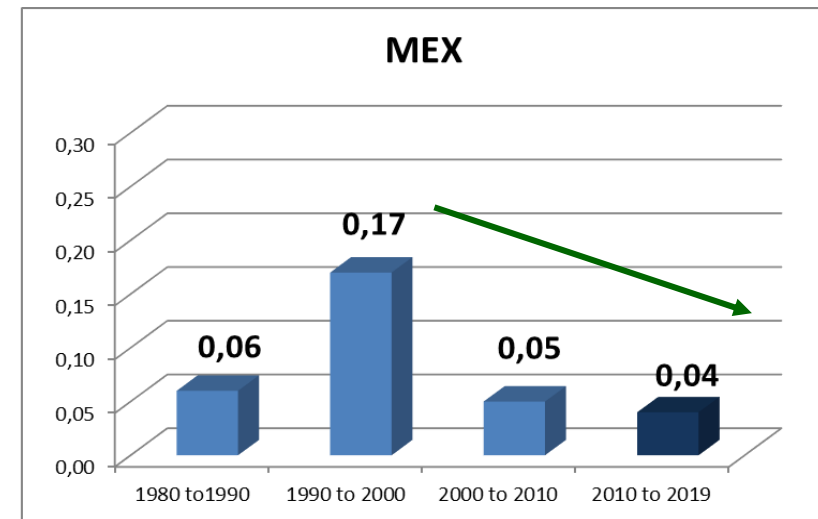
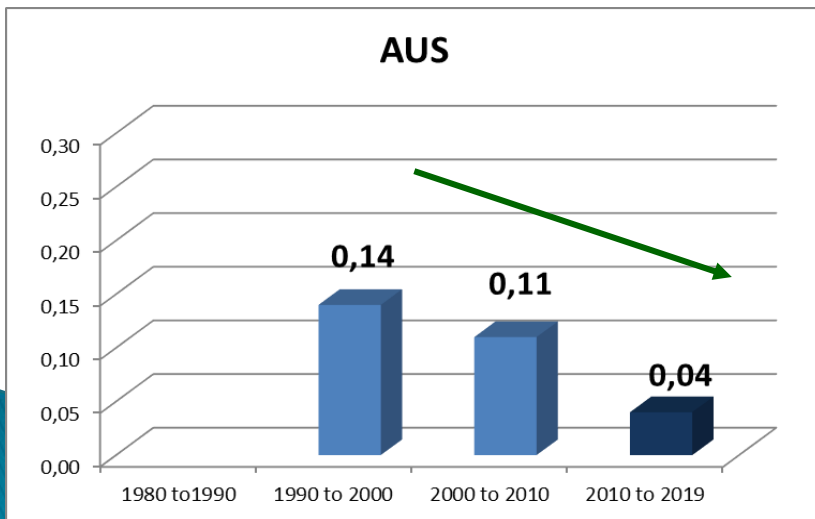
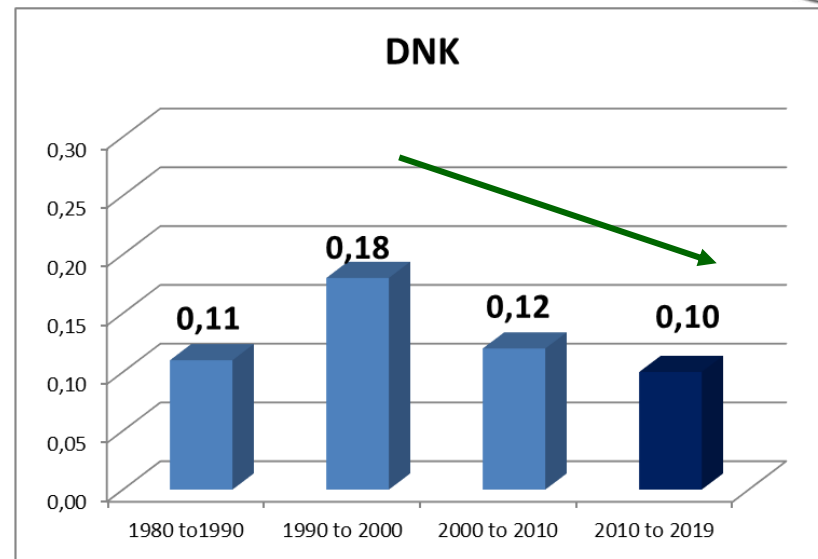
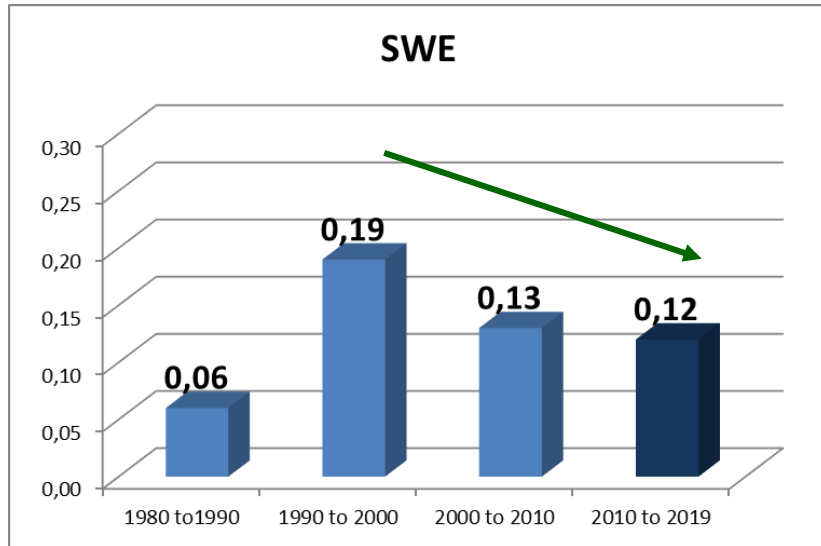
(The rate of increase shows an upward trend)



Average increase in inbreeding per year (The rate of increase is rising in nearly every period)

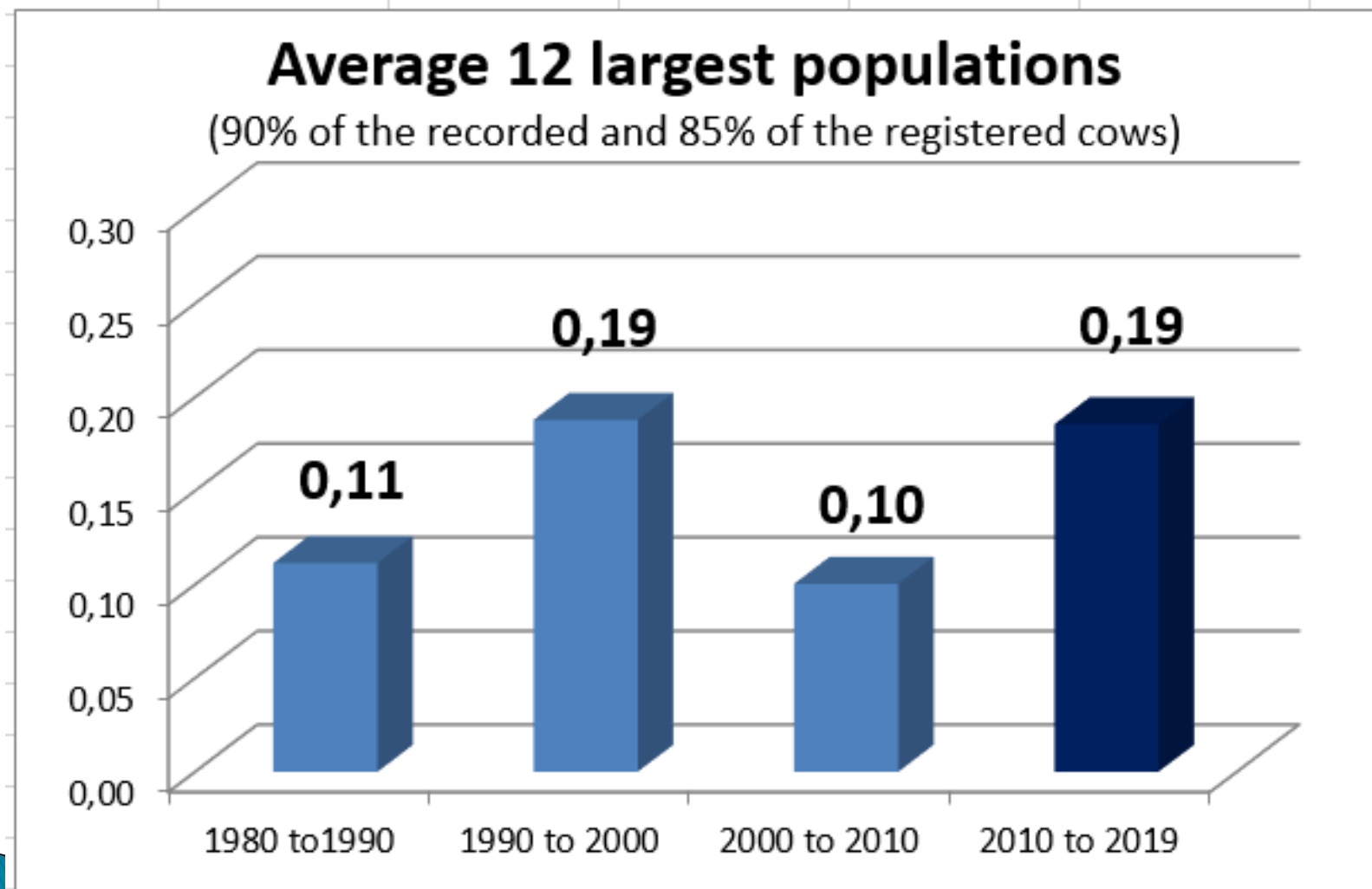


Average increase in inbreeding per year (The rate of increase is decreasing)





World Inbreeding Trend – Holsteins





Discussion

- ▶ Assessment of the results is based on
 - max. 1% increase per generation
 - i.e. in 4 years → 0,25% per year
- ▶ **Question:** Is the generation interval of 4 years in countries with genomic breeding programs still valid?
 1. The four years of generation interval did not change really, as at farm level farmers do not select different, or replace animals faster or less fast.
 2. Alternative analyses showed the same results when the inbreeding of a cow and of its dam were calculated and subtract from each other.
 3. You still get similar answers: When inbreeding increases it increases in all methods you apply.



Summary and conclusion

- ▶ The inbreeding should not be higher than 1% per generation (=4 yrs), i.e. **not higher than 0,25% per year**.
- ▶ Generation interval has not changed on farm level and is still about 4 years
- ▶ Monitoring of inbreeding by looking at the “**rate of change over a time period**” is a good tool.
- ▶ Genomics has increased the inbreeding rate in many countries.
- ▶ Some countries are already above 1% increase in inbreeding per generation!
- ▶ Since some countries use 80–90% imported semen the larger countries need to take care of inbreeding as many countries are using their semen. **AI and breeding organisations have a responsibility and should control inbreeding** more than in the past.
- ▶ Importing countries should consider inbreeding in exporting countries.
- ▶ WHFF will further monitor the inbreeding in the member countries.



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