

# Breeding programs compared across countries, continents, and breeds

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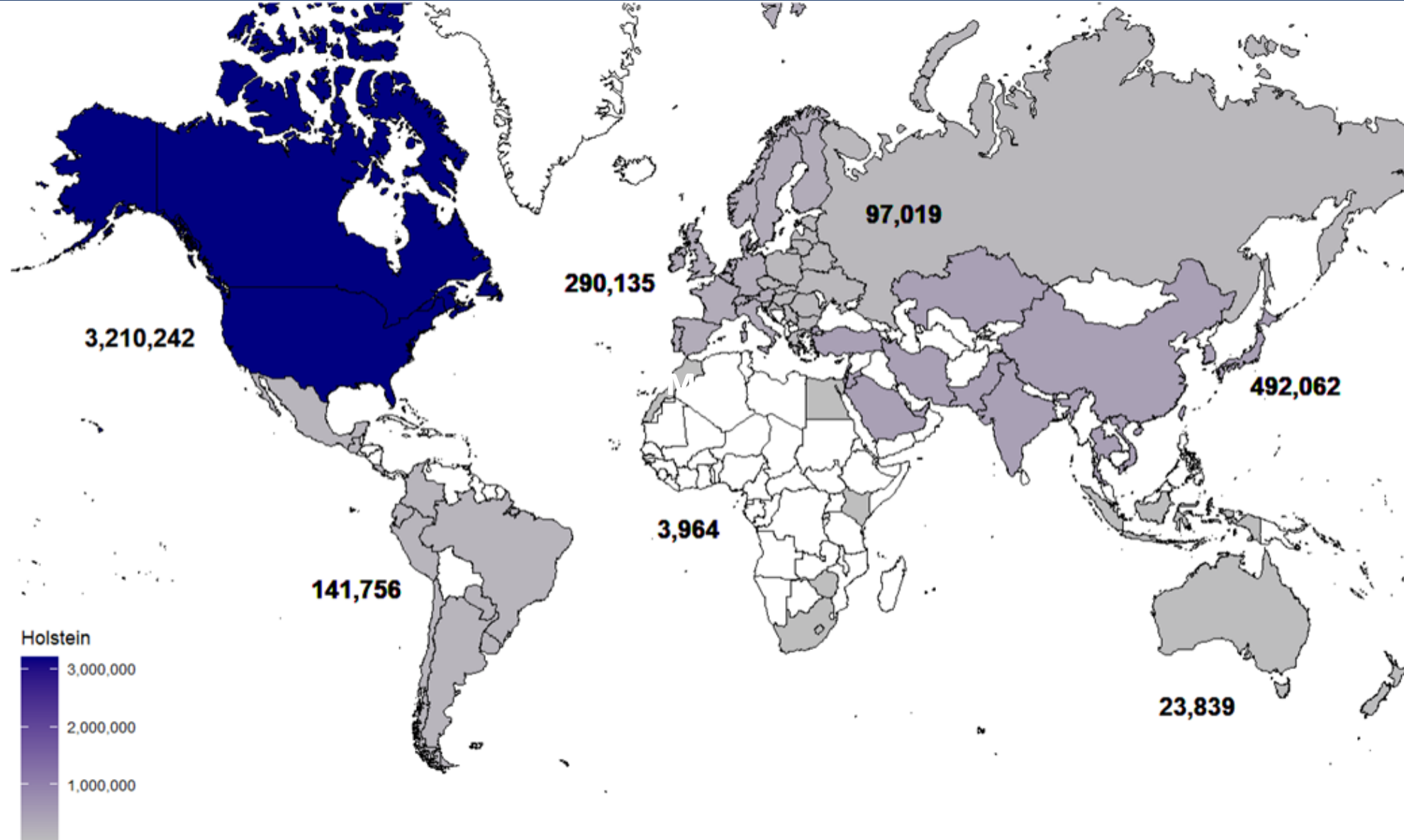
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# Data and edits

- **December 2023 official data on USA scale.**
- **Recent genotyped females born 2018-2023 from CDCB.**
  - Breeds **HOL** and **JER**.
- **Proven bulls born 2016-2017 from Interbull.**
  - Breeds **HOL**, **JER**, **BSW**, and **RDC**.
  - Milk-recorded daughters in  $\geq 10$  herds.
  - Evaluations for countries with at least 10 domestic proven bulls (DFS as 1 country).

# Recent female genotypes by continental region (Dec 2023)



# Continental regions defined for genotypes

Continent	Countries									
<b>N. America</b>	2	USA	CAN							
<b>L. America</b>	12	ARG	BRA	CHL	COL	CRI	ECU	GTM	MEX	PER
		PRI	PRY	URY						
<b>W. Europe</b>	17	AUT	BEL	CHE	DEU	DNK	ESP	FIN	FRA	GBR
		IRL	ITA	JEY	LUX	NLD	NOR	PRT	SWE	
<b>E. Europe</b>	17	BUL	BLR	CYP	CZE	EST	GRC	HRV	HUN	LAT
		LTU	POL	ROU	RUS	SRB	SVK	SVN	UKR	
<b>Africa</b>	5	EGY	KEN	MAR	ZAF	ZWE				
<b>Asia</b>	13	ARE	CHN	IND	ISR	JOR	JPN	KAZ	KOR	LBN
		PKN	SAU	TUR	TWN					
<b>Oceania</b>	3	AUS	IDN	NZL						

# Countries sending the most genotypes

- **Numbers of animals born in latest 5 years (both sexes, all breeds)**
- **Countries with advanced breeding programs have large databases and accurate predictions**
- **Many other countries have too little historical data to compute predictions**

Country	Cows genotyped
United States	3,571,054
Canada	320,350
Saudi Arabia	186,499
China	160,558
Japan	135,971
Italy	114,501
Brazil	102,000

# Genotyped **Holstein** females: General stats

- **Net Merit** averaged **\$480** in N. America and **\$211-381** in other continental regions.
- **Pedigree completeness** ranged from average of **64.2%** for Latin America to **86.1%** for western Europe.
- **Pedigree inbreeding** ranged from average of **8.7%** for Africa and Oceania to **9.6%** for North America.
- **Expected future inbreeding (EFI)** had a small range from **9.0%** in Oceania to **9.5%** in North America.
- **Genomic future inbreeding (GFI)** ranged from **9.4%** to **10.4%**.

# Genotyped females by continent - **Holsteins**

Continent	Net Merit	Pedigree Completeness	Pedigree Inbreeding	EFI	GFI
	(\$)	(%)	(%)	(%)	(%)
North America	480	84.2	9.6	9.5	10.4
Latin America	335	64.2	9.1	9.4	9.9
Western Europe	381	86.1	9.1	9.2	10.2
Eastern Europe	370	74.5	8.8	9.2	9.7
Africa	317	70.5	8.7	9.1	9.8
Asia	366	76.5	8.8	9.2	9.7
Oceania	211	75.2	8.7	9.0	9.4

# Genotyped females by continent - Jerseys

Continent	Net Merit	Pedigree Completeness	Pedigree Inbreeding	EFI	GFI
	(\$)	(%)	(%)	(%)	(%)
North America	304	87.9	8.9	9.0	7.7
Latin America	75	57.3	8.5	8.7	7.0
Western Europe	118	75.8	7.6	7.4	5.7
Eastern Europe	284	79.4	7.8	8.0	6.2
Africa	90	85.0	8.0	8.4	7.8
Asia	41	74.6	8.1	8.6	7.1
Oceania	1	63.9	8.1	8.1	7.1



# Proven bulls: General stats

- **Pedigree completeness averaged 98%** due to the Interbull exchange.
- **Holstein bulls had > 90% foreign sires** in 7 of the 20 countries, but only 1% in NZL and 11% in USA. Averages were 43% **foreign sires** in Holsteins and **Brown Swiss**, 12% in **Red Dairy Cattle**, and 9% in **Jersey**.
- **Sire's age at son's birth** averaged 2.2 to 2.9 years in 11 of the 20 countries for Holsteins, indicating rapid use of young sires. Other countries and breeds chose older sires of sons.
- **Proven bulls with genotypes** used in USA reference population ranged from 0-100% and averaged 66% in Holsteins.

# Comparing proven bulls of each breed by country

- Proven bulls born 6-7 years ago with daughters in  $\geq 10$  herds
- Variables and abbreviations defined:
  - **Ped%** Pedigree completeness back to 1980 (%)
  - **G%** Bulls with genotypes in the CDCB evaluation (%)
  - **NM\$** Net merit (average \$ by country of ID)
  - **EFI, GFI** Future inbreeding using pedigree or genomic data
  - **ForSire** Bulls with a foreign sire (%)
  - **SireGI** Generation interval from sire to son (years)

# Bull comparisons by country – Holsteins (+ Sim)

Country	Bulls	Daughters	Ped%	G%
USA	1754	1085	100	99
DEA	1005	348	97	0
DEU	590	871	100	88
NLD	444	1012	99	66
NZL	444	811	99	1
CAN	332	1125	100	100
JPN	309	61	97	22
FRA	282	1289	94	52
FRM	194	591	92	0
ITA	186	329	99	75
DFS	162	1593	99	41

Country	Bulls	Daughters	Ped%	G%
CHE	145	245	100	10
POL	96	307	93	22
SVN	82	107	91	1
ISR	79	266	85	5
KOR	71	36	94	0
AUS	64	234	92	39
ESP	60	185	97	42
GBR	42	642	98	93
CZE	23	473	100	78
LUX	14	343	100	86
BEL	13	476	99	85
<b>Globe</b>	6412	771	98	54

# Bull properties by country – Holsteins (+ Sim)

Cntry	NM\$	EFI	GFI	ForSire	SireGI
USA	543	10.0	11.1	11	2.3
DEA	202	1.1	.	38	4.1
DEU	378	8.6	10.1	79	2.4
NLD	326	7.8	9.8	58	3.0
NZL	-61	2.8	2.4	1	5.9
CAN	479	10.0	11.3	65	2.2
JPN	276	9.0	10.5	81	3.7
FRA	257	8.0	10.1	79	2.6
FRM	233	1.3	.	1	3.6
ITA	315	7.6	10.7	90	2.8
DFS	353	7.5	8.8	47	2.3

Cntry	NM\$	EFI	GFI	ForSire	SireGI
CHE	-23	5.0	9.3	50	4.0
POL	274	8.2	10.2	100	2.9
SVN	31	4.6	9.4	98	5.2
ISR	269	5.5	3.2	29	4.9
KOR	31	8.9	.	100	8.0
AUS	125	8.3	9.9	70	3.5
ESP	247	9.4	10.5	98	2.6
GBR	267	7.3	8.1	74	4.4
CZE	430	9.7	11.2	100	2.5
LUX	442	9.0	10.6	100	2.6
BEL	306	7.7	9.4	85	2.6
<b>Globe</b>	324	7.0	10.7	43	3.2

# Bull comparisons by country – Jerseys

Country	Bulls	Daughters	Ped%	G%	NM\$	EFI	GFI	ForSire	SireGI
USA	359	594	95	100	279	9.1	7.4	4	3.1
NZL	207	455	98	4	-7	2.8	2.6	6	5.9
DFS	56	941	99	63	326	4.9	3.1	7	2.4
AUS	21	229	89	24	-6	8.1	7.7	57	6.2
CAN	19	176	100	100	69	8.4	8.1	47	2.5
<b>Globe</b>	673	551	96	65	177	6.7	7.0	9	4.0

# Bull comparisons by country – Brown Swiss

Country	Bulls	Daughters	Ped%	G%	NM\$	EFI	GFI	ForSire	SireGI
DEA	157	213	96	93	436	5.4	6.3	37	4.4
CHE	100	287	99	39	123	5.2	0.3	32	3.7
ITA	57	116	99	93	289	6.2	6.8	63	3.8
USA	49	130	99	100	223	7.8	7.5	39	4.3
FRA	13	228	98	100	359	6.4	7.2	77	4.5
SVN	12	54	98	50	226	5.6	6.1	92	4.9
Globe	394	201	96	93	297	5.8	5.9	43	4.1

# Bull comparisons by country – Red Dairy Cattle

Country	Bulls	Daughters	Ped%	G%	NM\$	EFI	GFI	ForSire	SireGI
DFS	149	708	98	20	786	3.2	2.0	1	2.4
NOR	92	1177	97	0	652	2.2	.	4	4.4
NZL	27	56	95	0	438	2.1	.	33	8.3
CAN	18	99	100	94	412	7.3	5.8	33	5.3
AUS	15	90	76	0	432	3.2	.	60	6.5
GBR	11	147	83	64	57	6.1	4.2	27	9.4
USA	7	94	97	100	129	7.6	5.6	43	6.6
<b>Globe</b>	329	676	96	19	638	3.2	3.7	12	4.1

# Conclusions

- Foreign HOL bulls and genotyped females are **highly related** to the USA reference population, **except** ISR (3.2%) and NZL (2.4%) bulls.
- HOL **genetic merit** was higher in North America than in all other continental regions but varied more in other breeds.
- Breeders in many countries are choosing **genomic predictions** from USA.
- Predictions for foreign animals should be almost as accurate as for domestic animals, but **genetic correlations** are unknown in many new markets.



# Acknowledgments

- CDCB staff and industry cooperators for data



- Interbull for data on bulls



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