Agriculture and Agri-Food Canada | Agriculture et Agroalimentaire Canada

Challenges and opportunities for global dairy cattle breeding – A Canadian perspective

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Canada

Outline

- **Where we are**
- **Where we are going**

  - **Genetic level & progress**
  - **Inbreeding**
  - **Domestic & Foreign Markets of dairy genetics**
  - **Breeding strategies**

Data – Interbull April 2009 evaluations

- **Four breeds**
  - **Holstein (HOL), Red Dairy Cattle (RDC), Brown Swiss (BSW), Jersey (JER)**
- **5 indicator traits**
  - **Production:** **Protein kg**
  - **Type:** **Overall Udder**
  - **Longevity:** **Direct Longevity**
  - **Health:** **SCS**
  - **Fertility:** **First Service to Conception (Days Open)**
- **Overall virtual index: sum of 5 standardized EBV**

Data

- **Genetic level**
  - Bulls born in 2002-2003
- **Genetic progress**
  - Bulls born between 1997 and 2003
- **'Global' market**
  - All bulls born since 1986
    - No. of daughters for production evaluations in various countries
- **Country of origin for each bull**
  - Country where bull has largest number of daughters

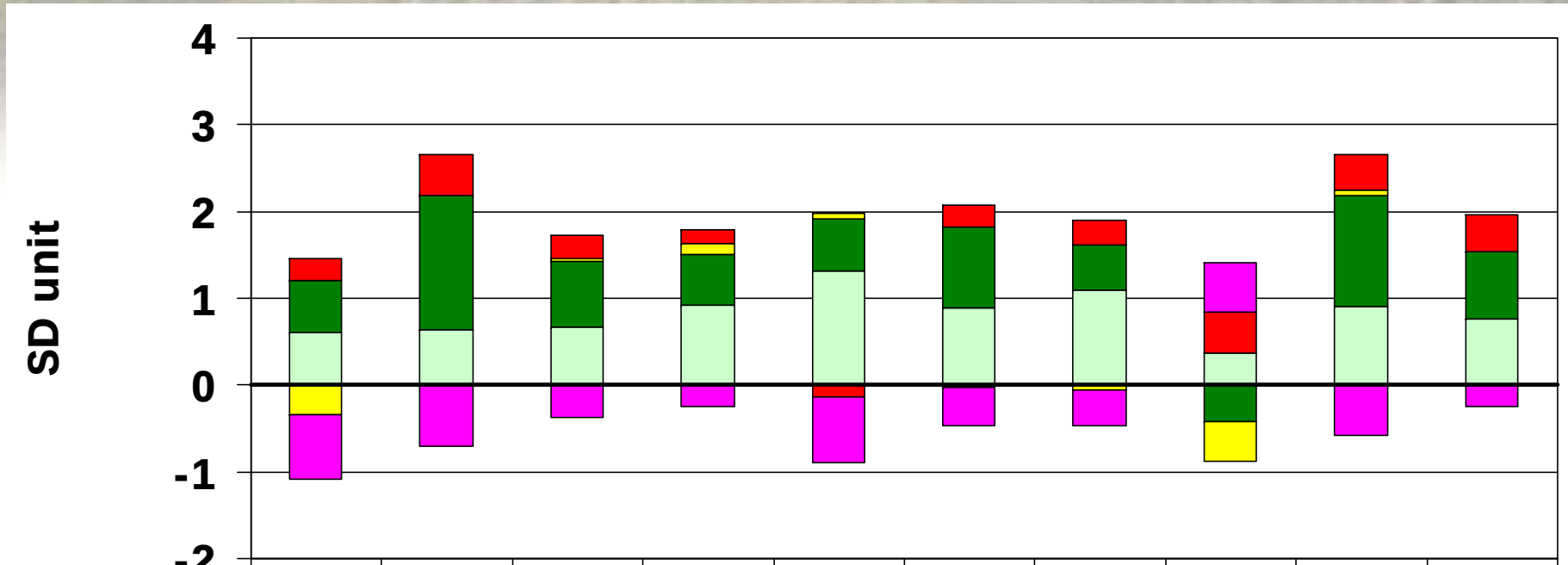
Data

- **Inbreeding**
  - **US (AIPL, 2009)**
  - **Canada (Stachowicz et al., 2009)**

Number of production proven bulls per year

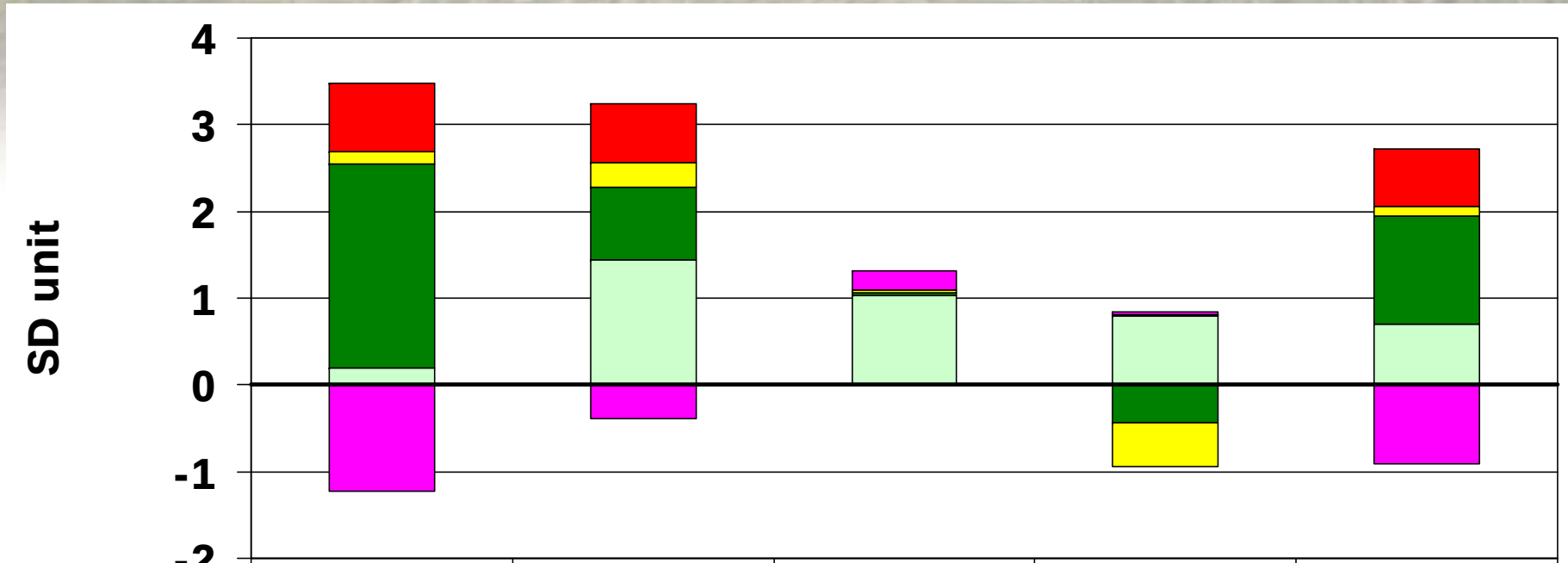
	HOL	RDC	BSW	JER
1997	6,817	546	443	410
1998	6,459	505	398	432
1999	6,150	465	438	439
2000	5,937	530	406	454
2001	5,956	515	376	460
2002	5,950	433	323	417
2003	5,751	435	325	405

Average proof of bulls born in 2002-'03 - HOL



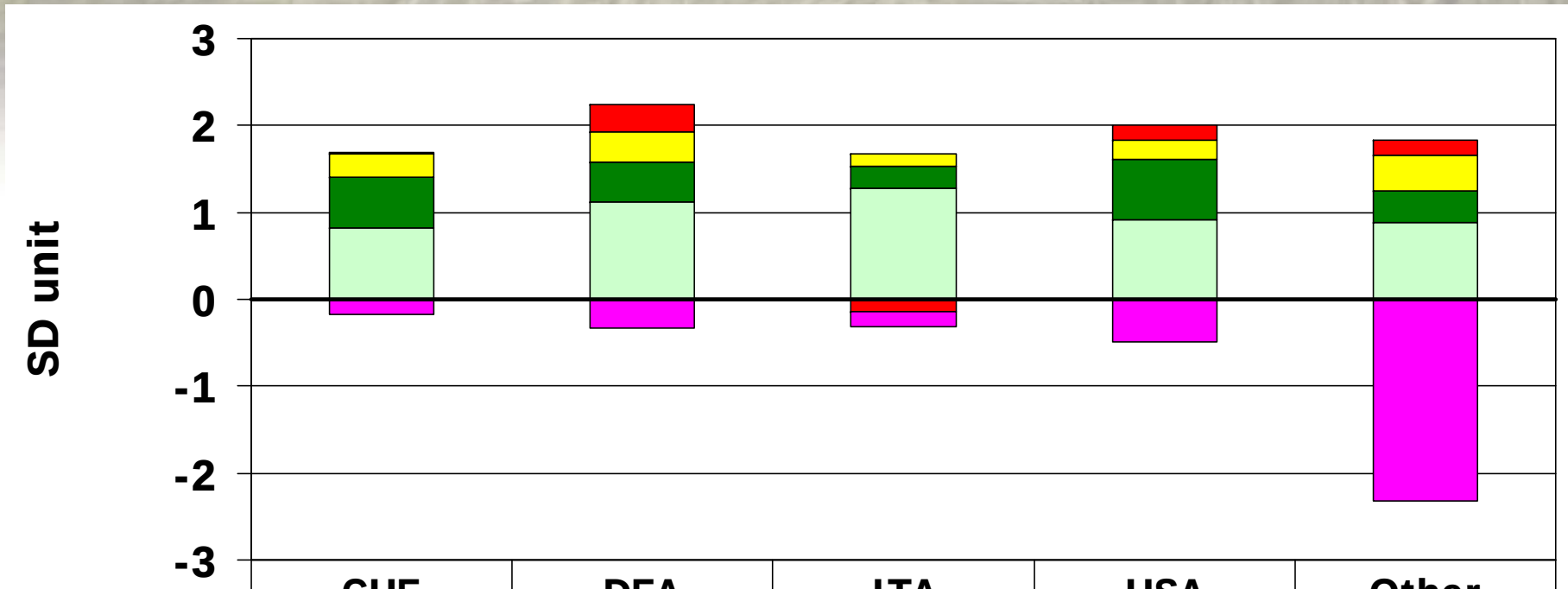
	AUS	CAN	DEU	DFS	FRA	ITA	NLD	NZL	USA	Other
Fertility	-.743	-.698	-.379	-.251	-.757	-.445	-.407	.567	-.573	-.233
Longevity	.251	.471	.270	.159	-.137	.251	.285	.483	.408	.432
SCS	-.342	-.006	.023	.129	.067	-.023	-.057	-.454	.061	-.013
Udder	.602	1.548	.764	.594	.601	.931	.533	-.428	1.286	.762
Protein	.610	.642	.669	.916	1.310	.888	1.088	.361	.902	.768

Average proof of bulls born in 2002-'03 - RDC



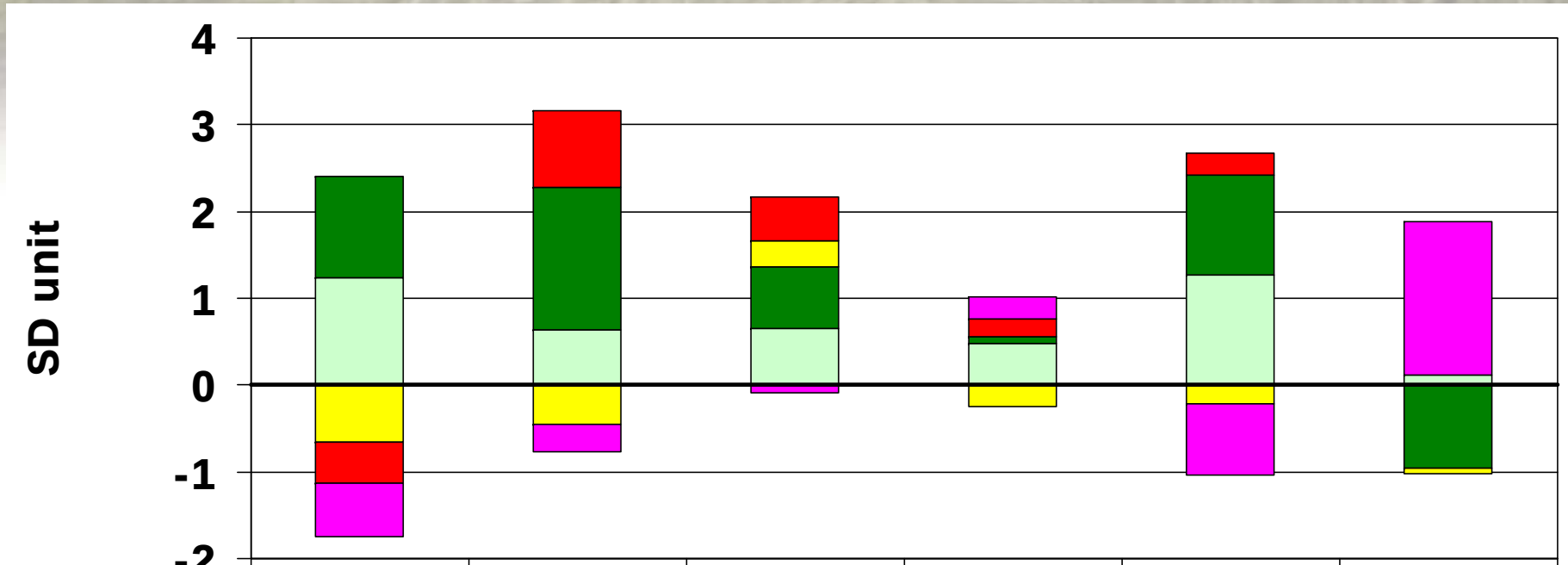
	CAN	DFS	NOR	NZL	Other
Fertility	-1.220	-.396	.220	.038	-.904
Longevity	.780	.678		.010	.667
SCS	.152	.285	.017	-.508	.114
Udder	2.341	.838	.034	-.429	1.246
Protein	.201	1.435	1.037	.795	.699

Average proof of bulls born in 2002-'03 - BSW



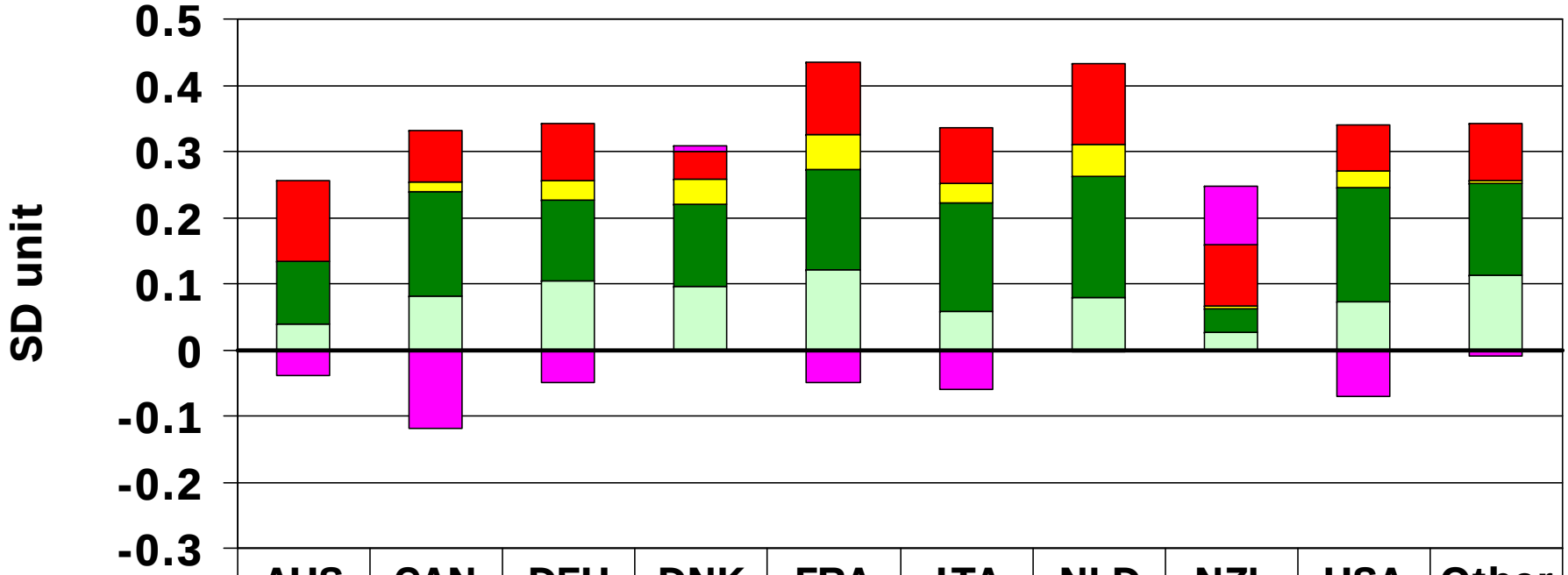
	CHE	DEA	ITA	USA	Other
Fertility	-.180	-.331	-.170	-.490	-2.320
Longevity	.015	.317	-.148	.182	.162
SCS	.260	.338	.144	.219	.415
Udder	.595	.459	.257	.693	.370
Protein	.816	1.127	1.272	.918	.877

Average proof of bulls born in 2002-'03 - JER



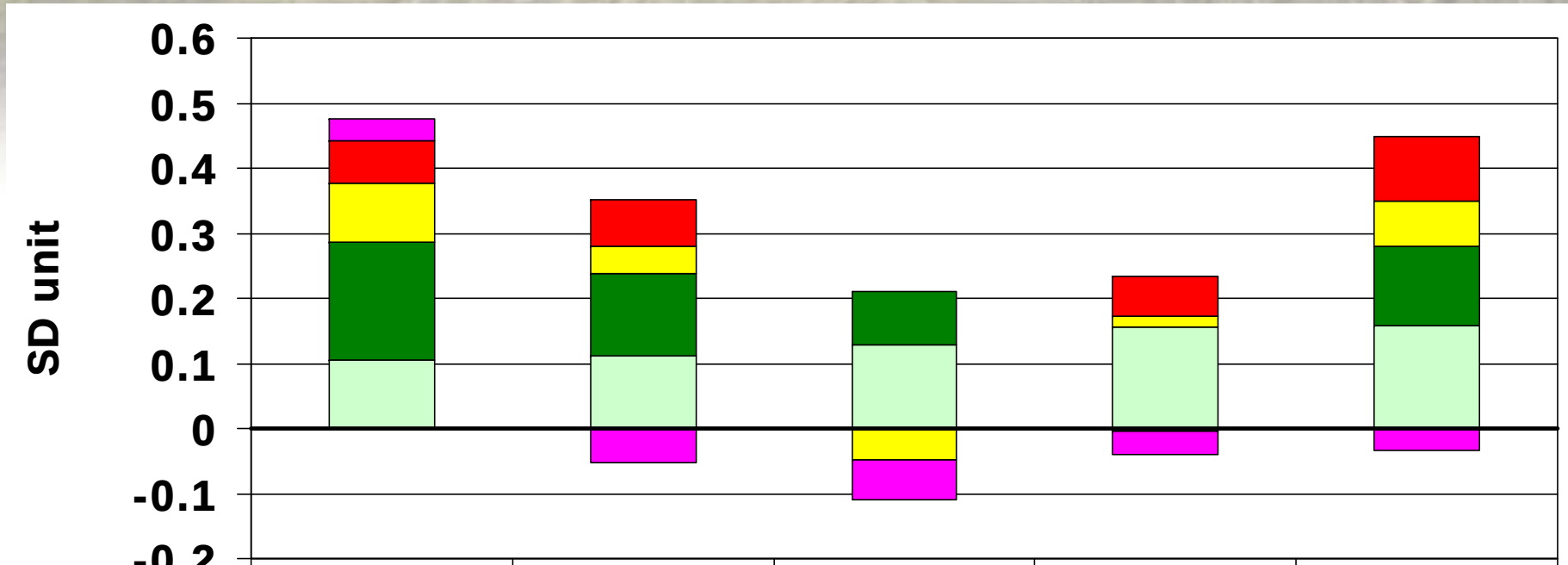
	AUS	CAN	DFS	NZL	USA	Other
Fertility	-.610	-.310	-.085	.239	-.834	1.770
Longevity	-.481	.881	.512	.205	.238	
SCS	-.656	-.453	.290	-.242	-.209	-.067
Udder	1.171	1.641	.717	.078	1.154	-.950
Protein	1.238	.639	.653	.486	1.275	.116

Genetic progress of bulls (1997-'03) - HOL



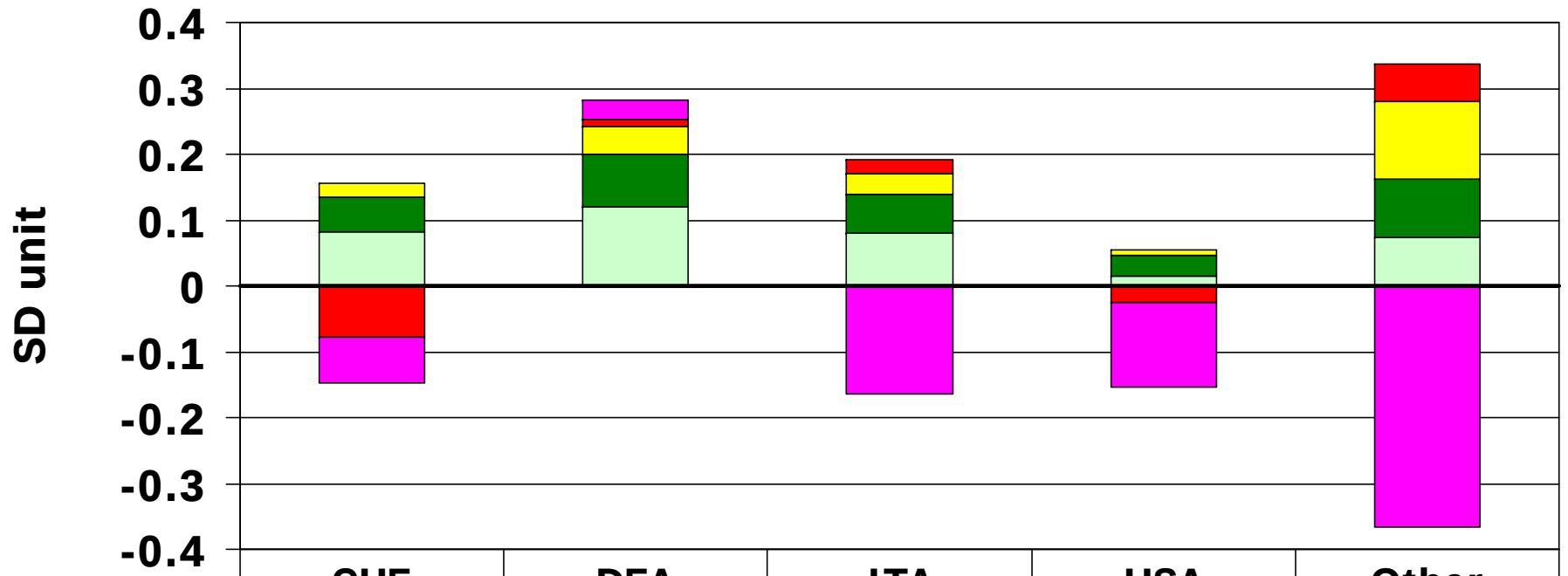
	AUS	CAN	DEU	DNK	FRA	ITA	NLD	NZL	USA	Other
Fertility	-.037	-.118	-.050	.008	-.050	-.061	-.003	.090	-.071	-.010
Longevity	.122	.079	.086	.043	.108	.084	.121	.091	.070	.088
SCS	-.001	.015	.029	.038	.054	.030	.049	.005	.026	.004
Udder	.095	.156	.122	.124	.150	.164	.182	.036	.172	.139
Protein	.039	.082	.105	.095	.122	.058	.080	.026	.073	.112

Genetic progress of bulls (1997-'03) - RDC



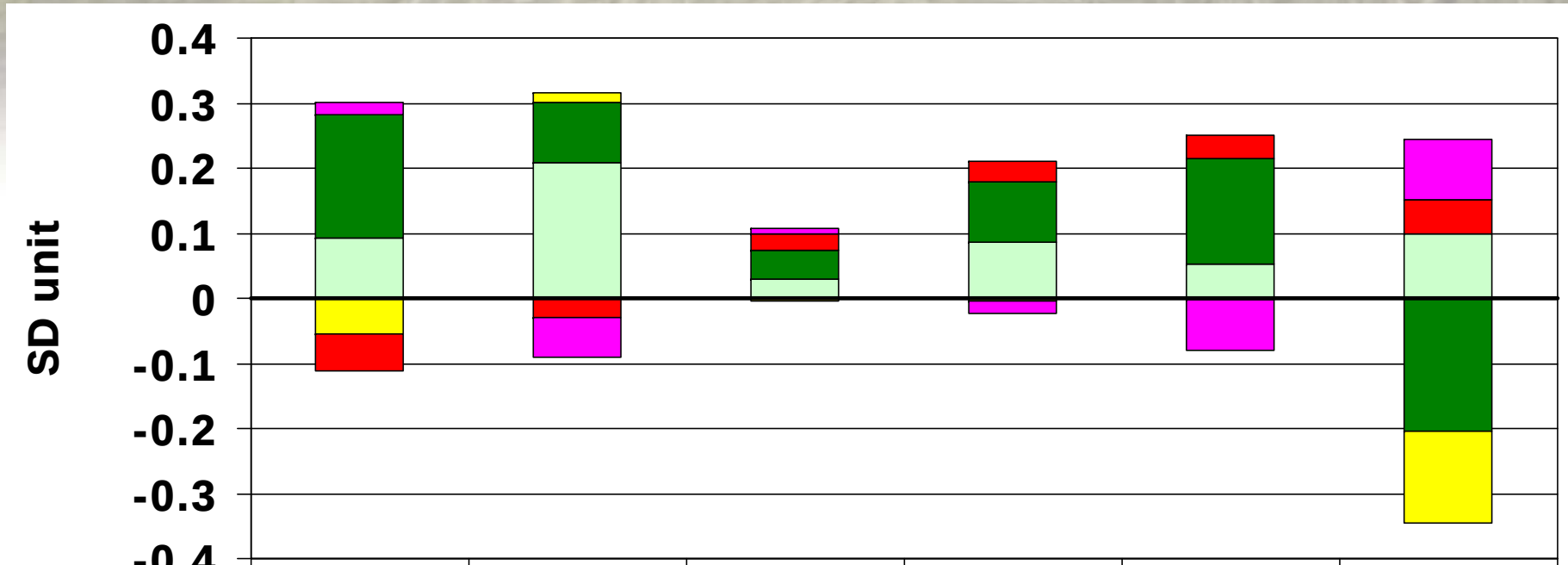
	CAN	DFS	NOR	NZL	Other
Fertility	.032	-.052	-.062	-.036	-.033
Longevity	.067	.071		.061	.099
SCS	.090	.044	-.048	.017	.069
Udder	.181	.125	.083	-.005	.122
Protein	.105	.112	.128	.155	.158

Genetic progress of bulls (1997-'03) - BSW



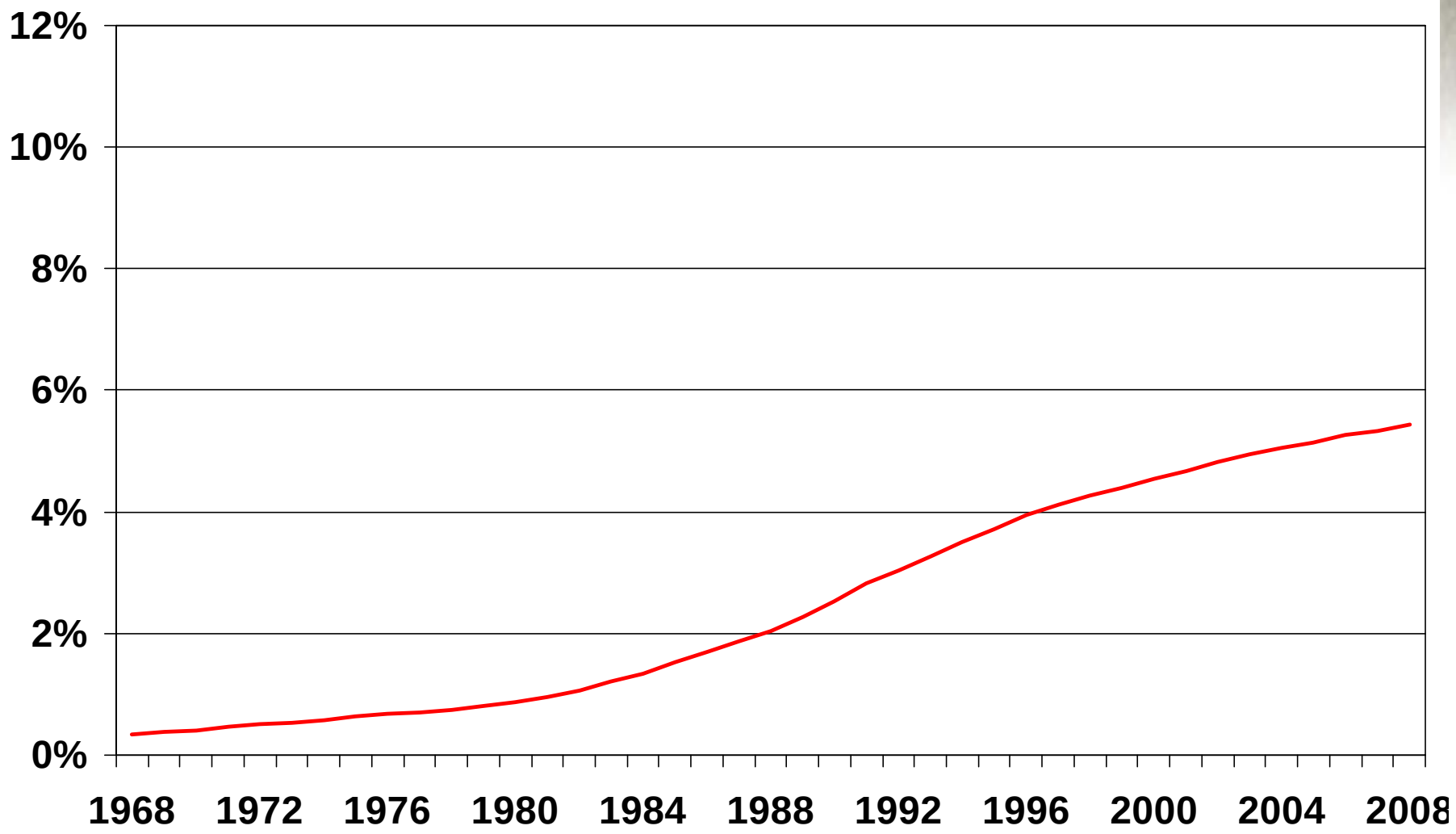
	CHE	DEA	ITA	USA	Other
Fertility	-.070	.030	-.165	-.128	-.367
Longevity	-.078	.010	.021	-.026	.057
SCS	.021	.043	.032	.008	.117
Udder	.051	.080	.058	.032	.090
Protein	.083	.120	.080	.014	.073

Genetic progress of bulls (1997-'03) - JER

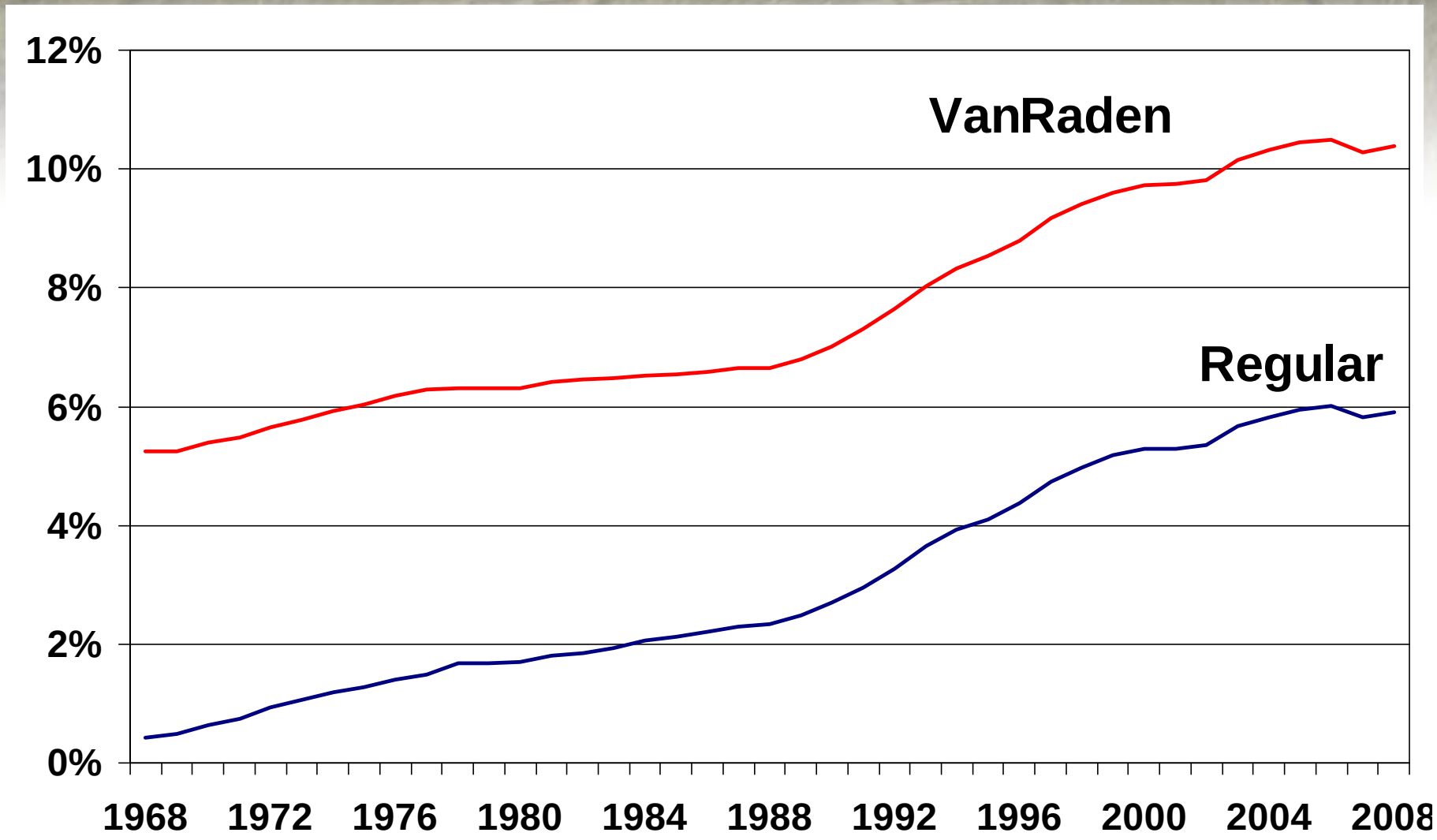


	AUS	CAN	DFS	NZL	USA	Other
Fertility	.019	-.062	.010	-.018	-.077	.094
Longevity	-.058	-.029	.025	.032	.036	.052
SCS	-.054	.013	-.004	-.005	-.002	-.141
Udder	.190	.093	.044	.092	.162	-.204
Protein	.092	.209	.029	.087	.052	.099

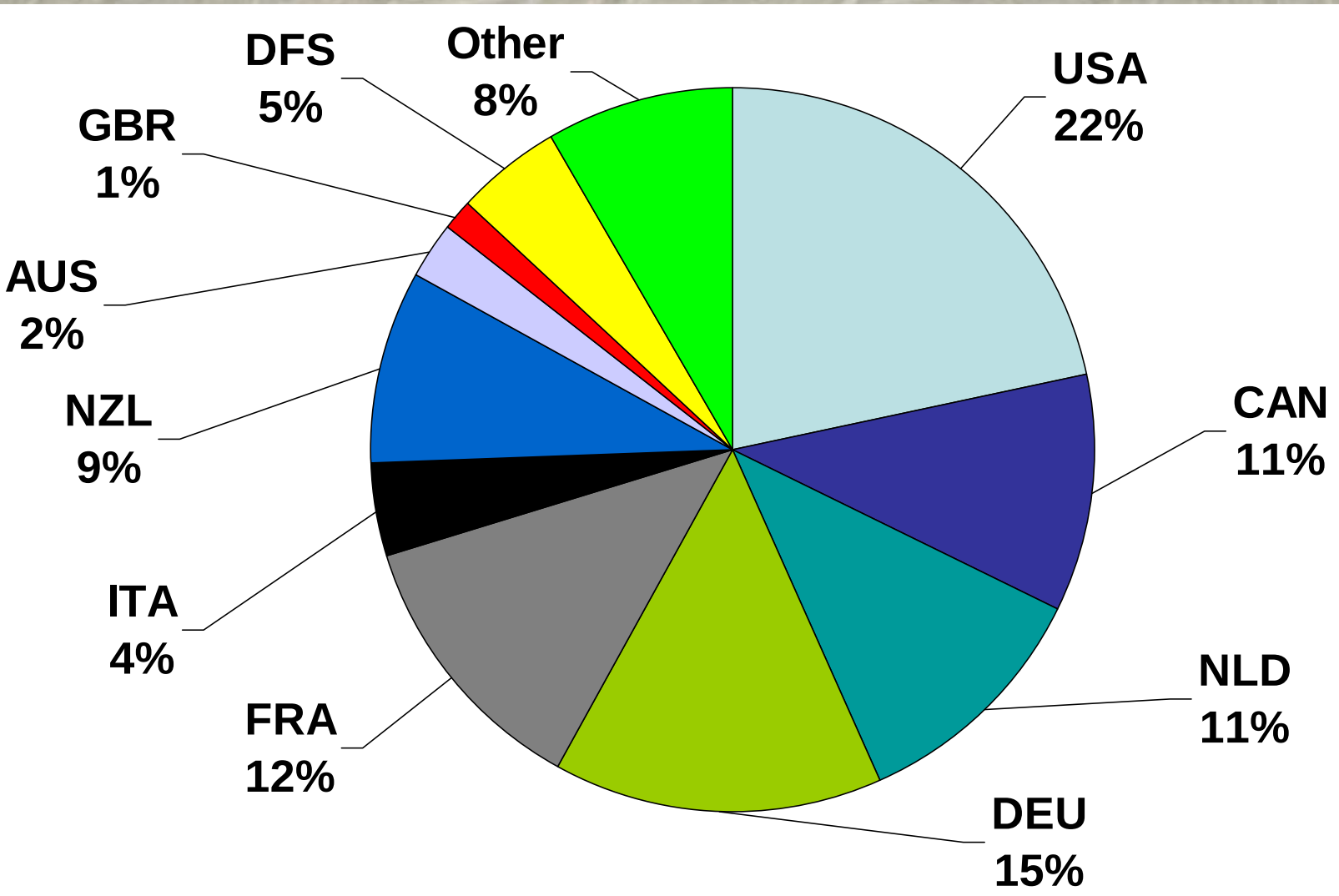
Inbreeding trends – HOL US (AIPL)



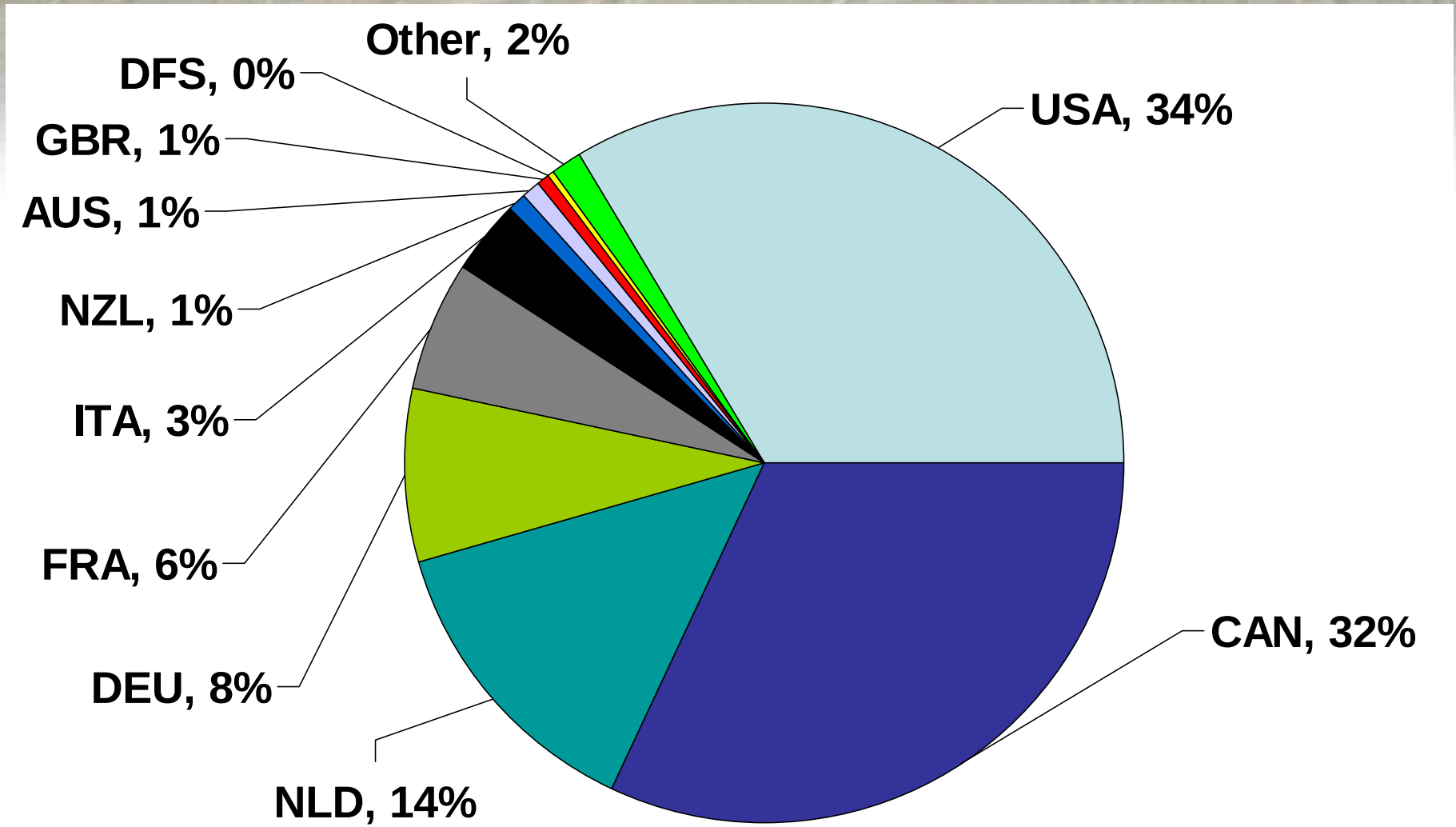
Inbreeding trends – HOL Canada (Stachowicz et al., 2009)



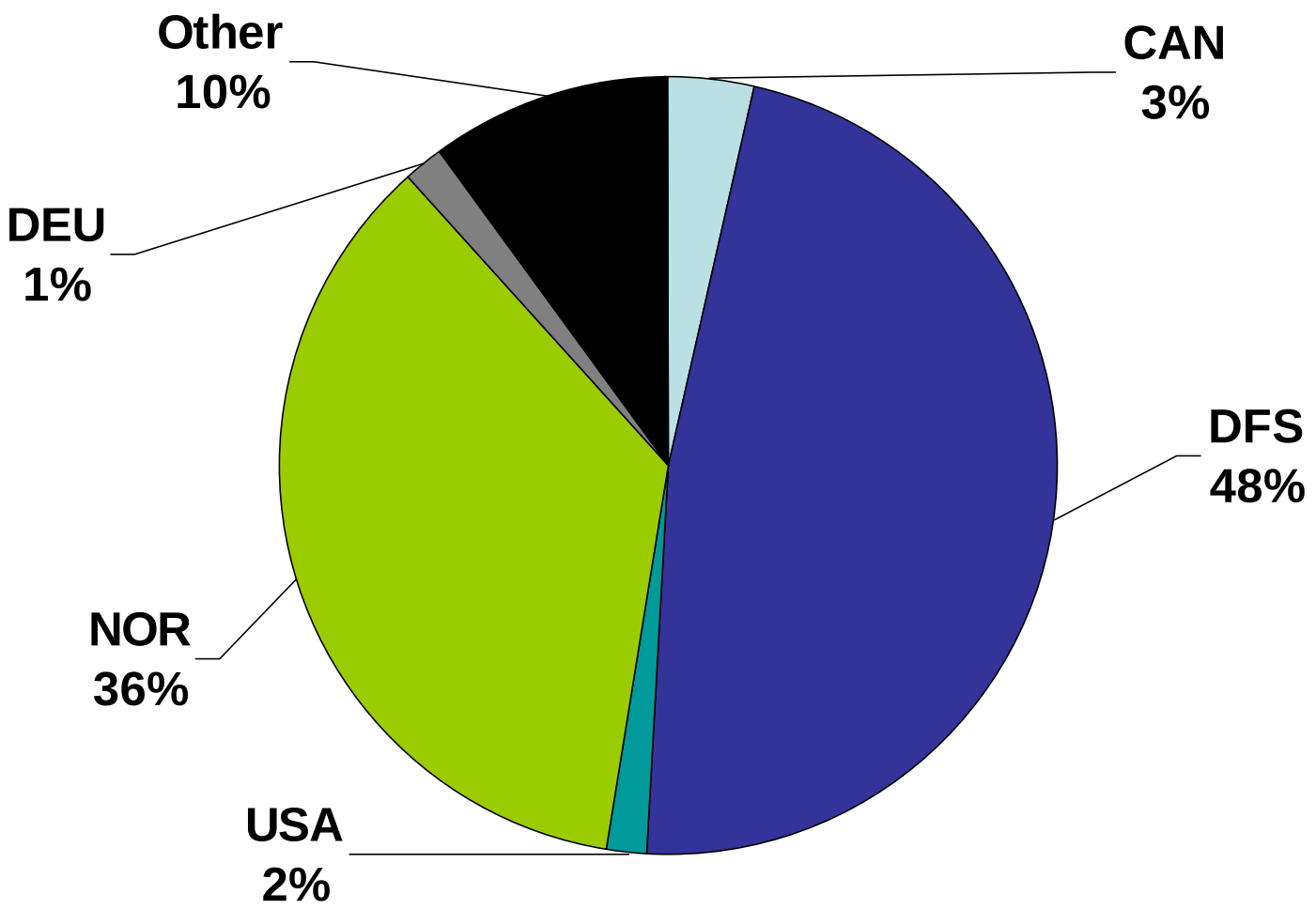
Global Market by country of origin – HOL
N=50,930,477



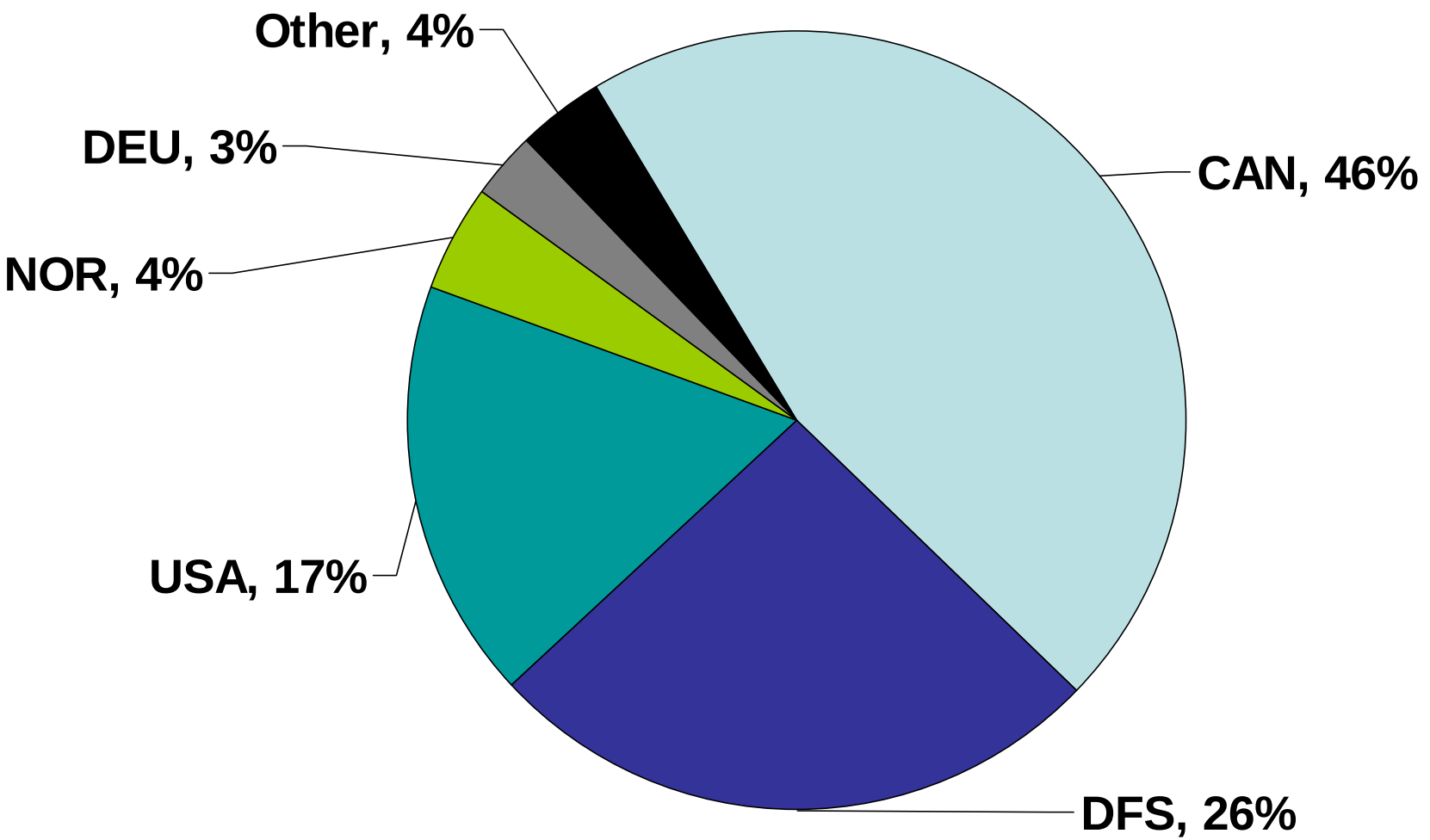
Percentage of Foreign Market (22%) – HOL
N=11,090,314



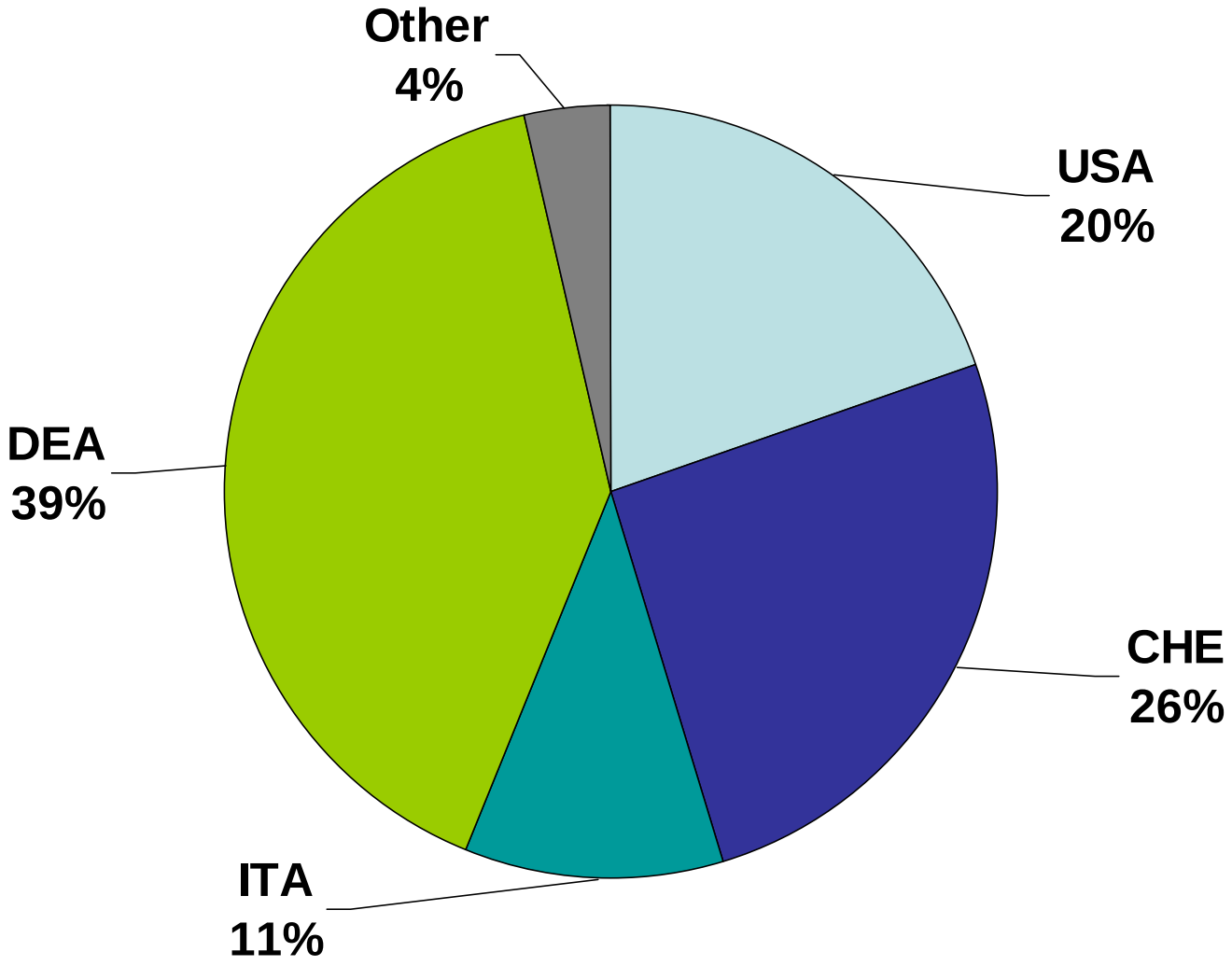
Global Market by country of origin – RDC
N=4,779,081



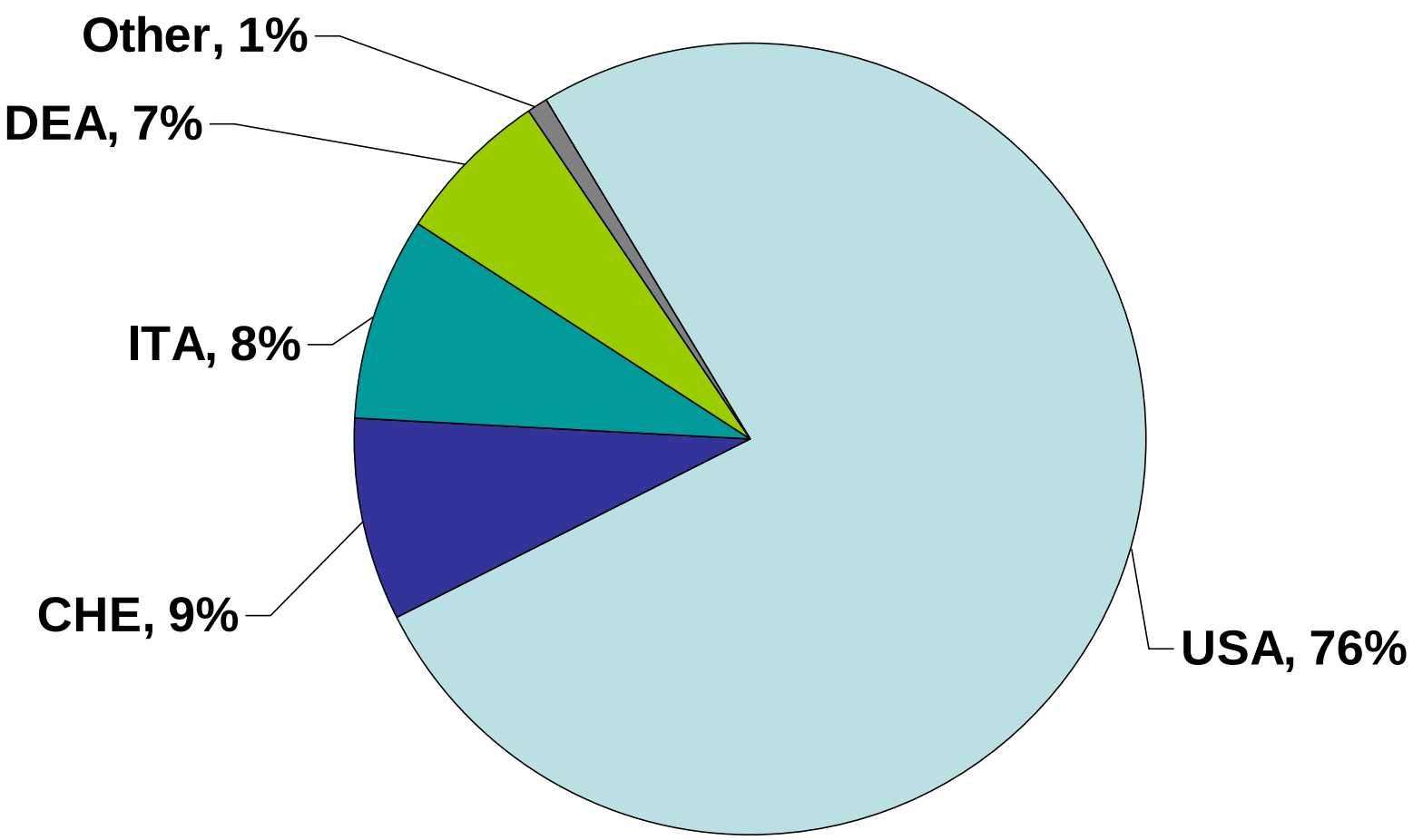
Percentage of Foreign Market (5%) – RDC
N=220,007



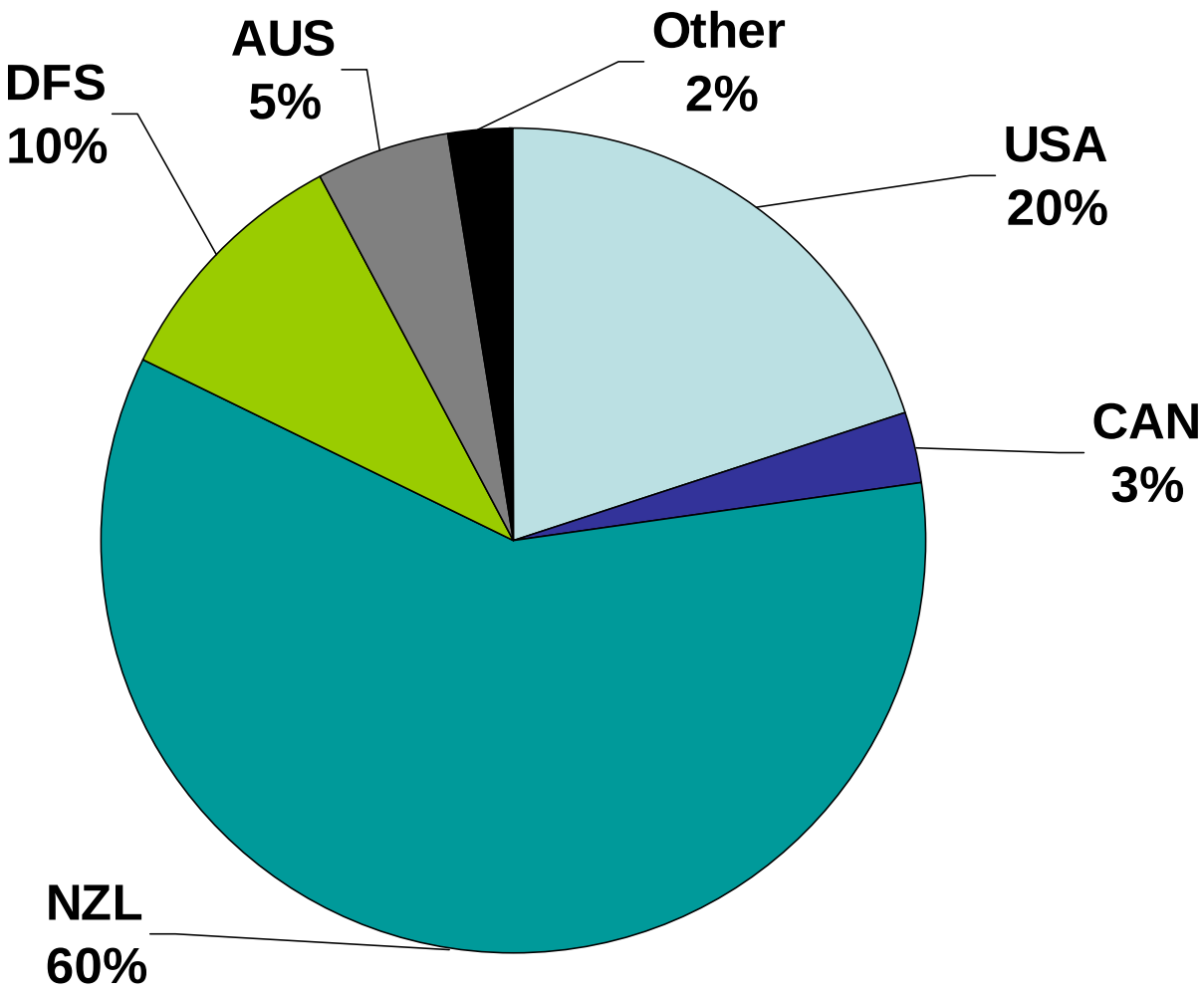
Global Market by country of origin – BSW
N=2,390,154



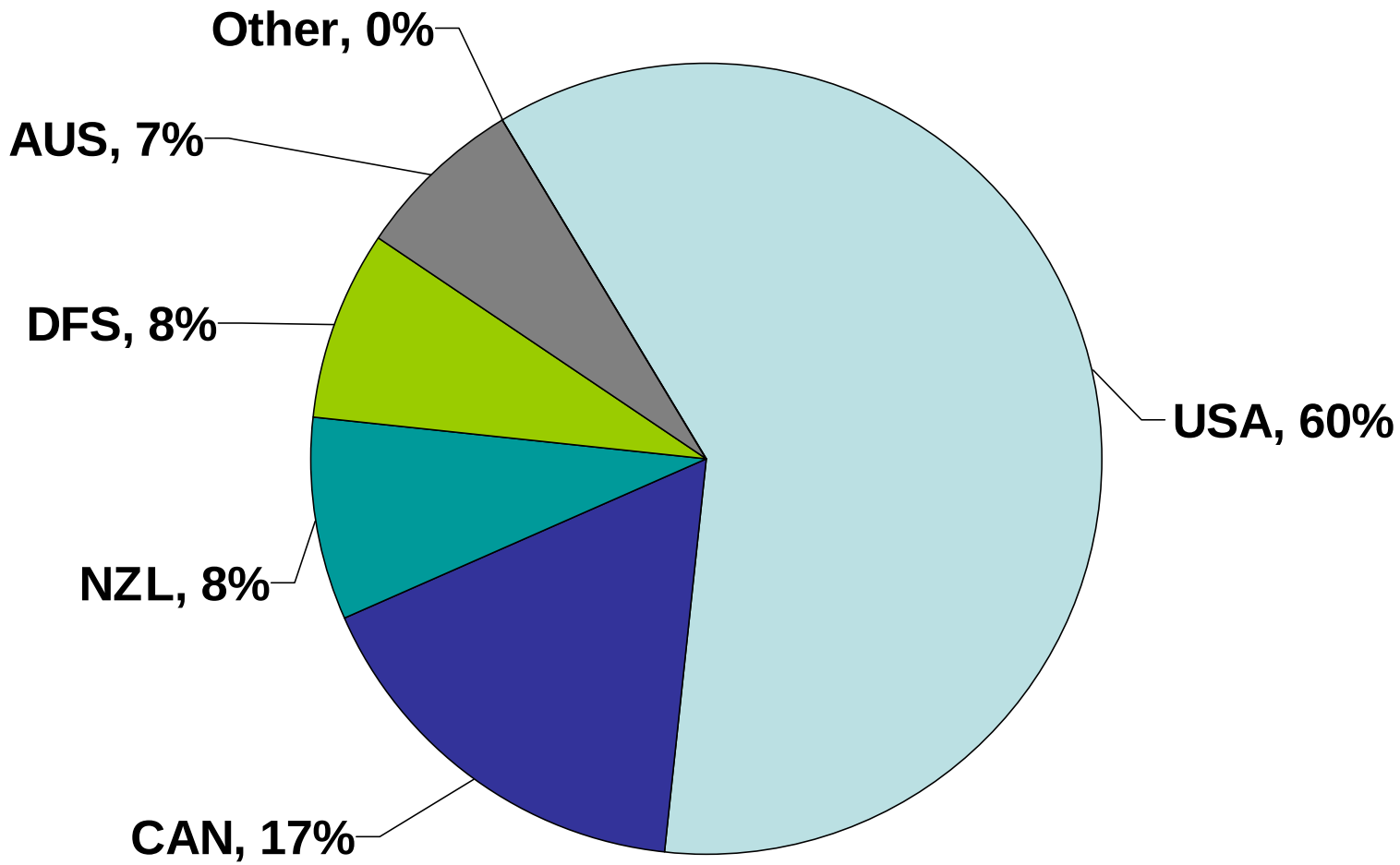
Percentage of Foreign Market (21%) – BSW N=503,434

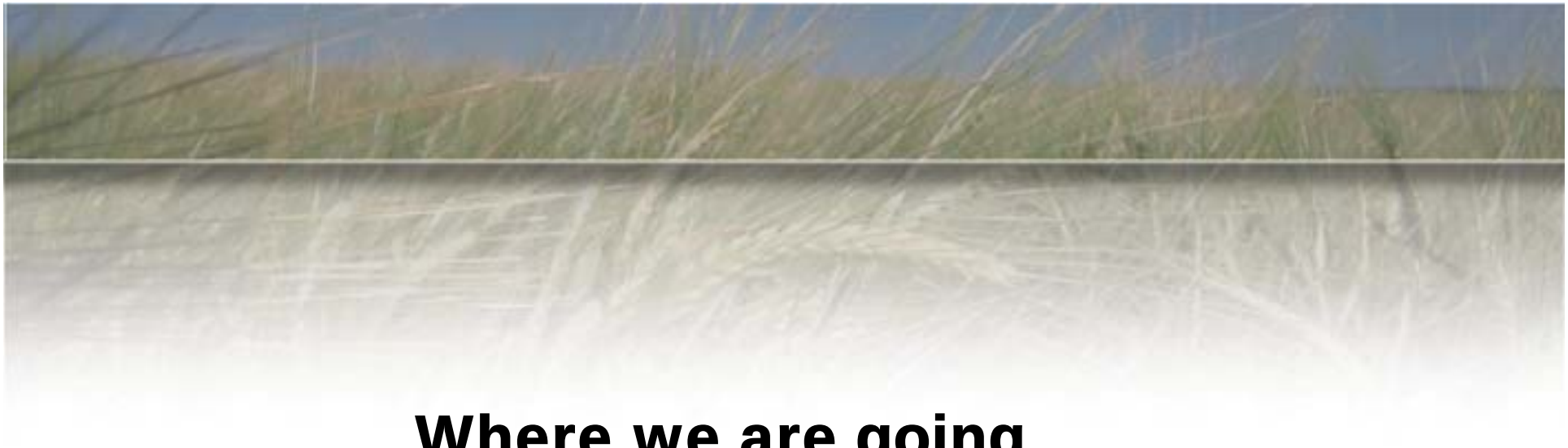


Global Market by country of origin – JER
N=4,360,179



Percentage of Foreign Market (10%) – JER
N=447,620





Where we are going

From real data to simulations

The potential of genomics

- Selection for or against known genes +++
- Selection assisted by markers +++
- Development of new drugs +
- Cow management assisted by markers +
- Parentage verification ++++
- Support for traceability ++
- Transgenics (GMO) -

Evolution of genotyping costs

Year	Type of marker	Number of markers per panel	Cost per marker
1990	Genetic test	1	40 $
2000	Microsatellite	12	3 $
2005	SNP	10,000	0.04 $
2007	SNP	50,000	0.005 $

The bottom line

- **Big event for the dairy cattle breeding industry**
- **Fast adoption by AI organizations**
- **Genomic selection is already part of the business**

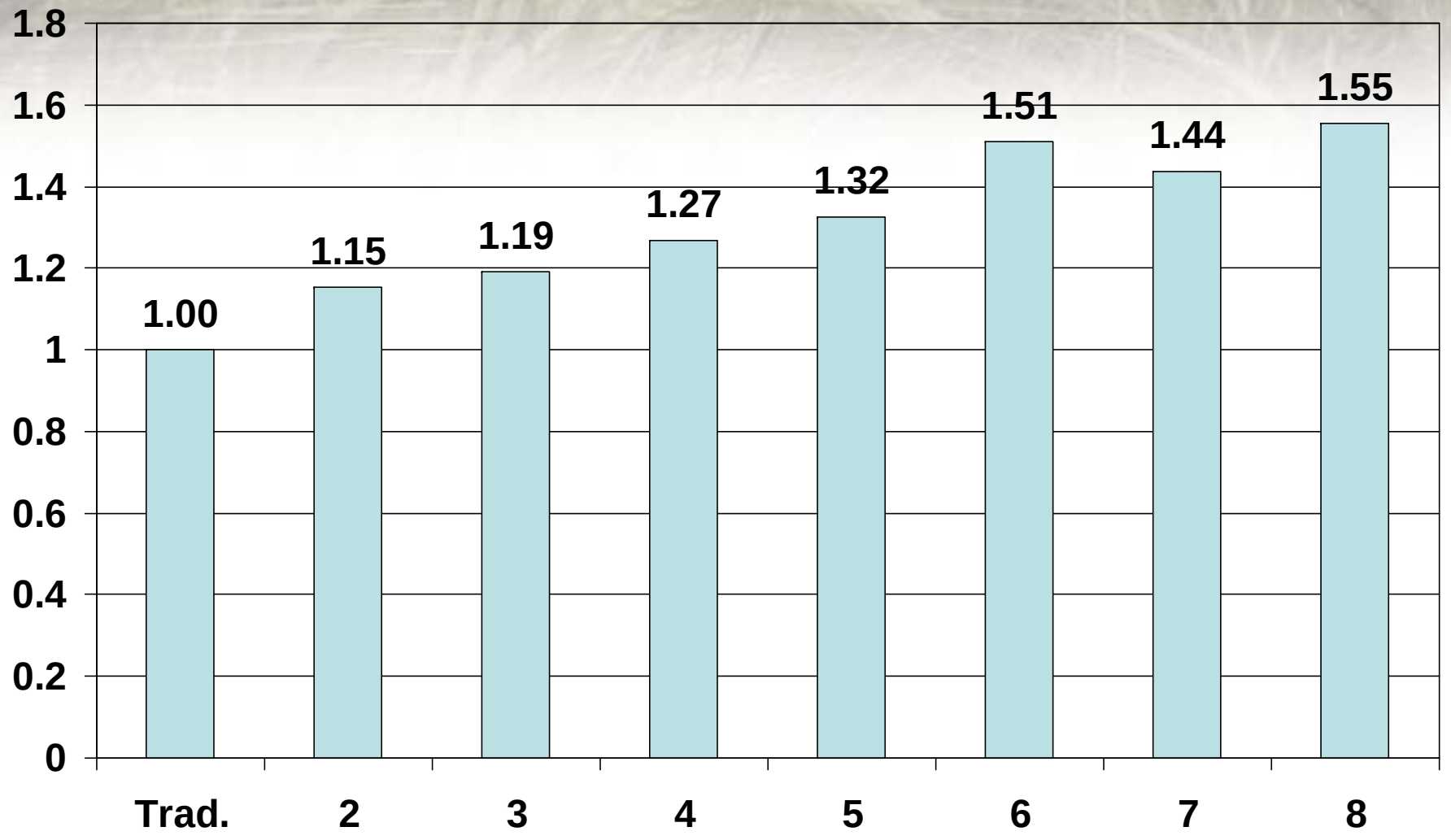
Genomic selection in the world

- North American “Consortium” (USA, Canada)
- The Netherlands
- New Zealand & Ireland
- Germany
- Australia
- Nordic Countries
- European Collaboration

Genetic progress for 3 selection schemes when GEBV reliability is 60 %

Selection scheme	Proof REL	Sire-son interval (years)	LPI points per yr	% more progress
Progeny testing only	90 %	5.5	171	0
Pre-selection of young bulls on GEBV, then progeny testing	90 %	5.5	187	10
Genotyped young bulls used as sires of bulls and cows	60 %	1.8	272	59

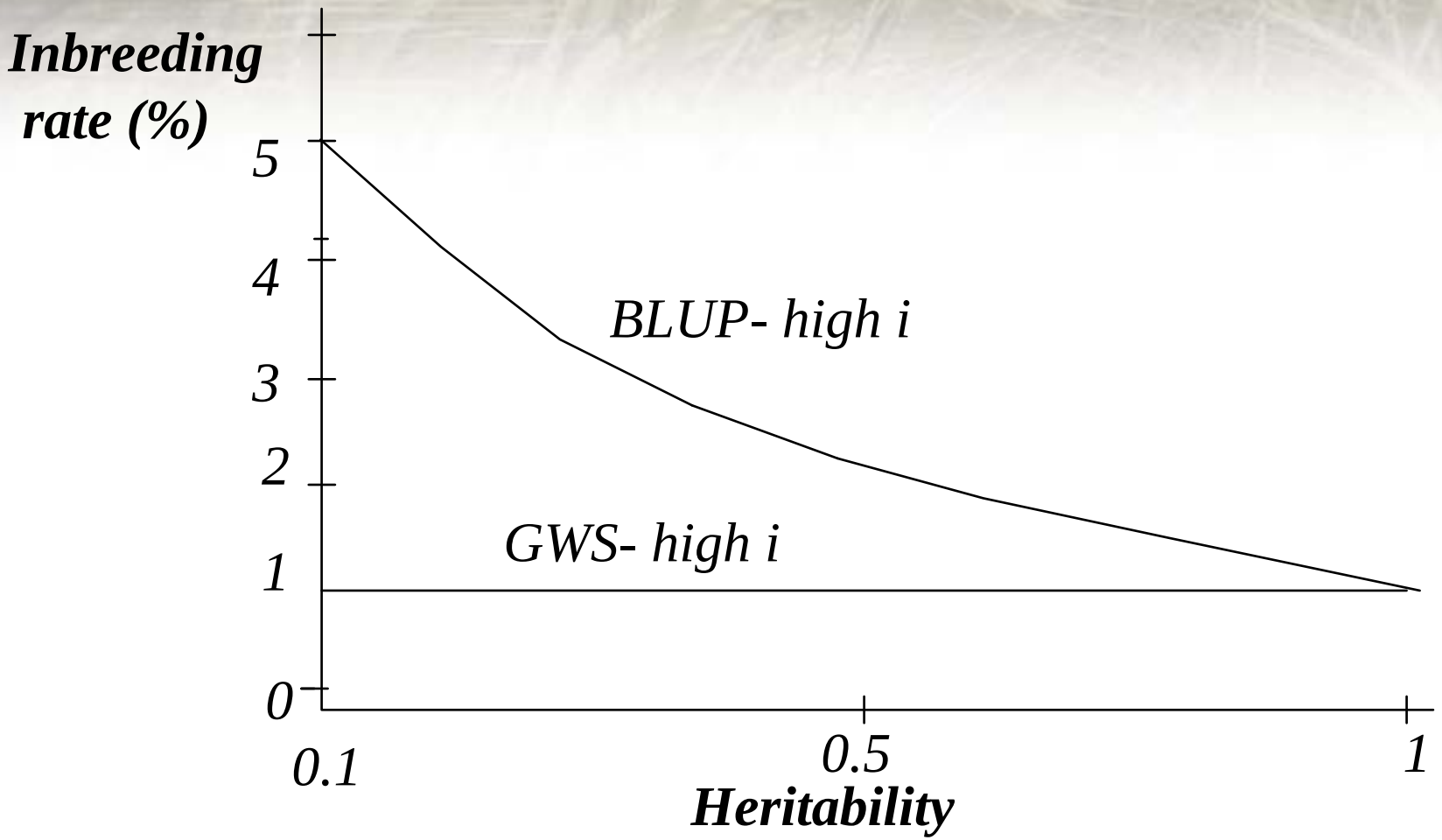
Genetic gain (Wickham et al., 2009)



Effect of genomic selection on inbreeding

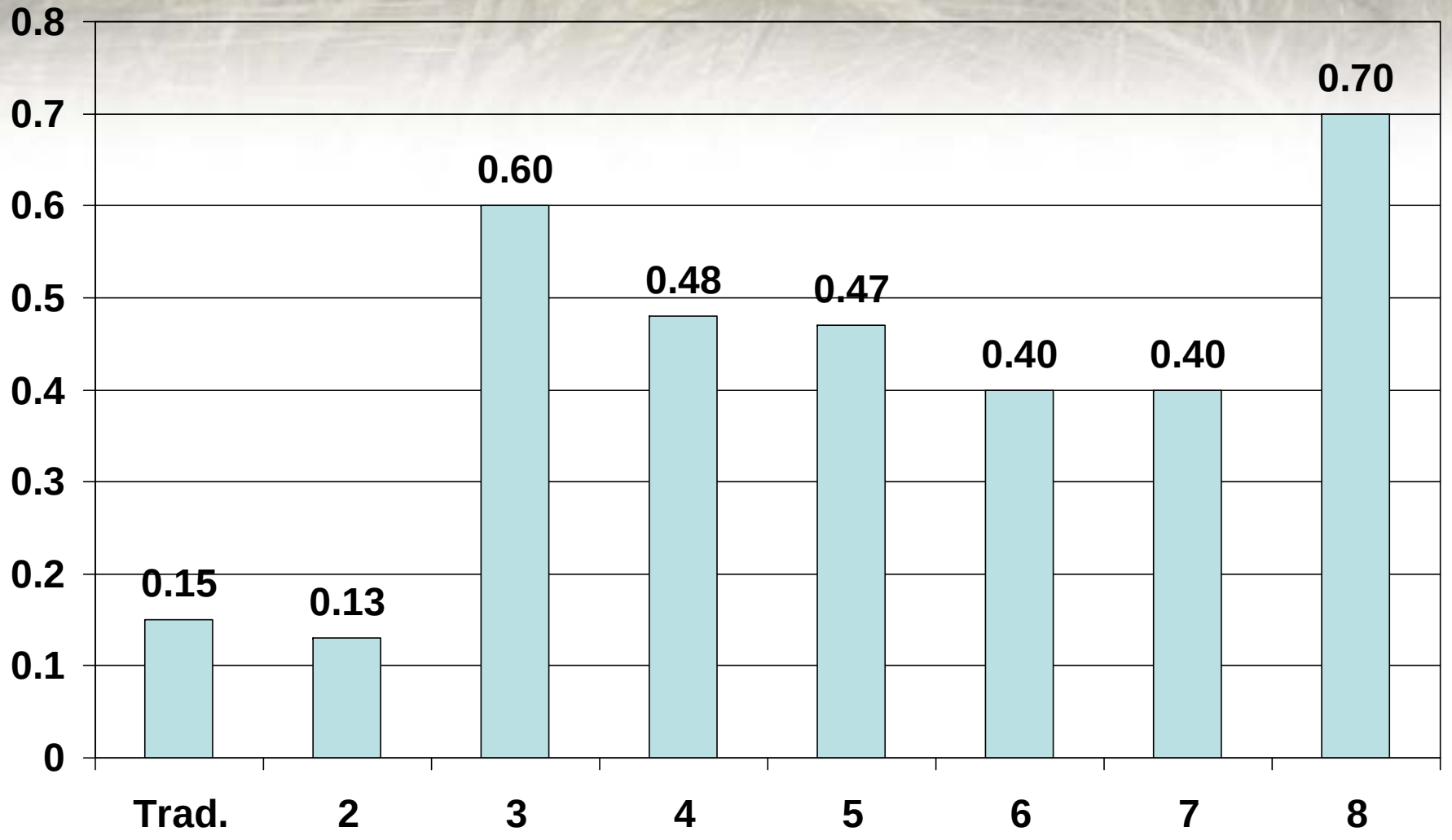
- SNP panels should allow better monitoring of inbreeding
- Less inbreeding per generation since less co-selection of sibs (less reliance on PA for selection)
- However, shorter generation interval may reduce or eliminate this advantage

Inbreeding rate per generation (20 males, 200 females)



Adapted from Daetwyler et al. (2007)

Inbreeding rate per year (Wickham et al., 2009)



Conclusion

- Traditional progeny testing has produced tangible and successful results
- Genetics competition varies by country and breed
- Inbreeding is raising but recent monitoring measures have slow down the yearly rate

Conclusion

- **Genomics is already part of the dairy industry**
- **However, real data have yet to confirm simulation results**
  - **In terms of genetic estimate, reliability and inbreeding**

Impact on AI industry

- **Creation of collaboration/consortium rarely seen before**
  - **Still competitors, but more open sharing**
- **Reduction of progeny testing**
  - **New products on the market**
  - **Different price system**
- **Changes in breeding strategies**
  - **Opportunity for new ideas outside the box**

Impact on Breed Societies

- **Collaboration among countries for breeds other than Holstein**
- **Parentage testing**
  - **May have to change herd book policies**
- **Potential to act as national repository of cow sample/genotypes and GEBV**

Impact for producers

Commercial

- Heifer/cow management with low density panel
- Faster genetic progress with more accurate selection of sires

Breeder

- 'Obliged' to genotype elite stock for sale/export
- GEBV & Genotype has now become an added value
- Faster genetic progress with more accurate selection of sires

Warning …

- There is a need of transition period before full implementation of genomic selection
- Collection of phenotypes must continue
  - Need to run traditional GE in order to continuously produce EBV for SNP estimation
  - Identification of novel traits and subsequent evaluation
- **Proven sires are still significantly more reliable than genomically tested bulls**