The impact of genomic selection on North American dairy cattle breeding organizations

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The Semex Alliance, USDA and Canadian Dairy Network

Genomic selection in North America

- 1992: Creation of Cooperative Dairy DNA Repository (CDDR) – 7 AI organizations, with USDA coordination
- 2006: Agreement between USDA and CDDR members for research project on genomic selection using 50k panel
- 2007: Cooperation between USDA, CDN, University of Guelph

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Genomic selection in North America

- 2008: First unofficial genomic evaluations
- 2009: Official genomic evaluations in the US and Canada
- April 2013: Genomic evaluations of males open to all (females open since 2009)

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Impact of genomic selection on breeding organizations

- Genetic evaluation centres
- AI industry
- Elite breeders
- Breed associations
- Milk recording and data processing agencies
- Commercial dairy producers
- Research institutions

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Impact on North American genetic evaluation centres

- Many new issues to address (enhancement of evaluation methods, genotype quality control, frequency of computations, extension, international collaboration, etc…)
- Genomic selection also raises new questions about who invests in the genetic improvement system (data, genotypes, bull proofs, money) and who benefits from it

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Impact on North American genetic evaluation centres

Canada

- CDN already completely financed by industry (since 1994)
- AI component of user fees changed from number of bulls progeny tested to number of bulls marketed using genomic evaluations

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Impact on North American genetic evaluation centres

USA

- Evaluations carried out by government (USDA) until April 2013
- USDA wanting to concentrate on research
- Council on Dairy Cattle Breeding (CDCB) responsible for delivery of genetic evaluation services since April 1, 2013
- Holstein traditional type evaluations still calculated by Holstein USA

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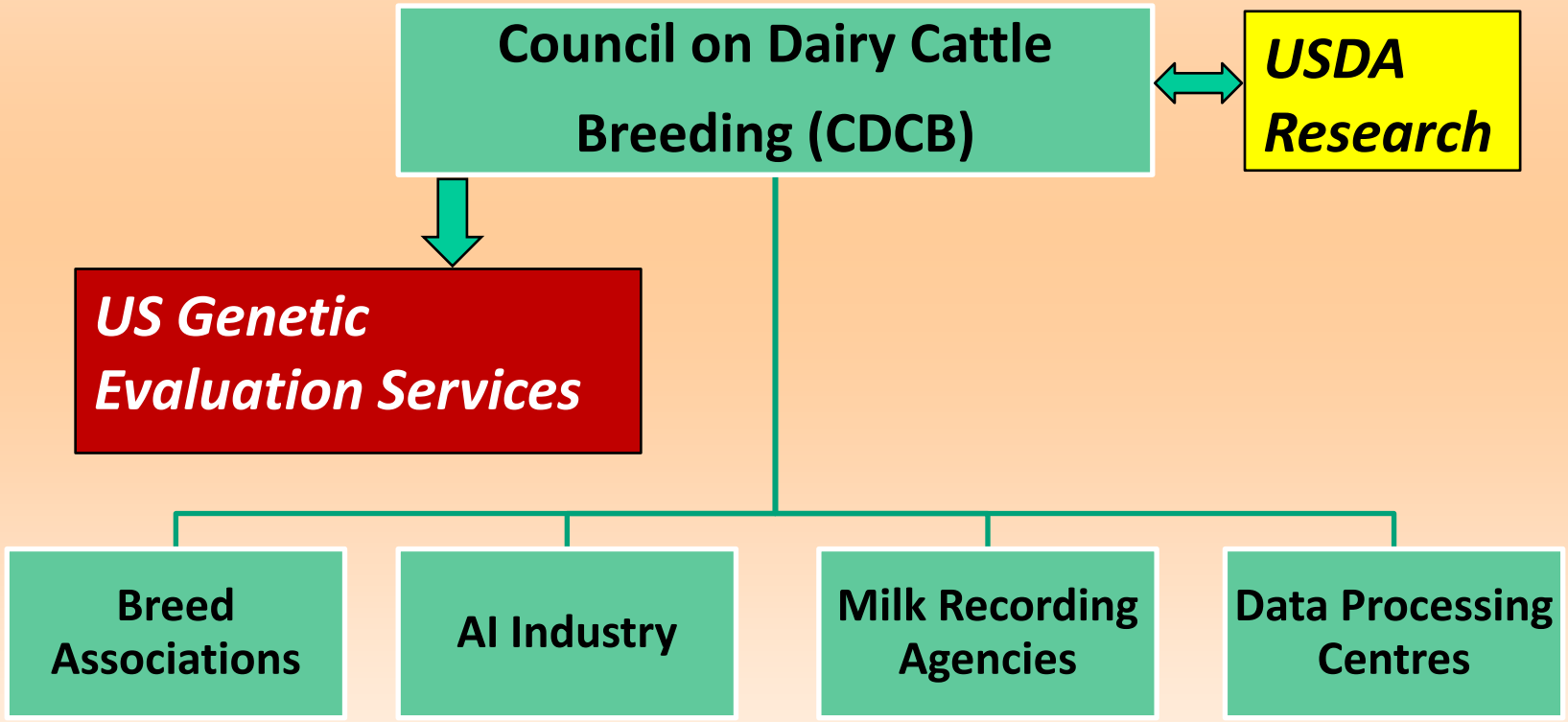
Impact on North American genetic evaluation centres



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Impact on North American genetic evaluation centres

USA

- **Fees to sustain CDCB based on:**
  - **Genomic evaluations for bulls and cows (initial fee)**
  - **Genomic evaluations for marketed bulls (service fee)**
  - **Different fees based on contributions of users to genetic improvement system**

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Impact on AI industry

- Many young bulls genotyped
- Younger parents
- Less formal progeny testing, but more bulls entering service overall (young + proven)
- Strong competition for young bulls with top genomic evaluations
- Increased price of bull acquisitions

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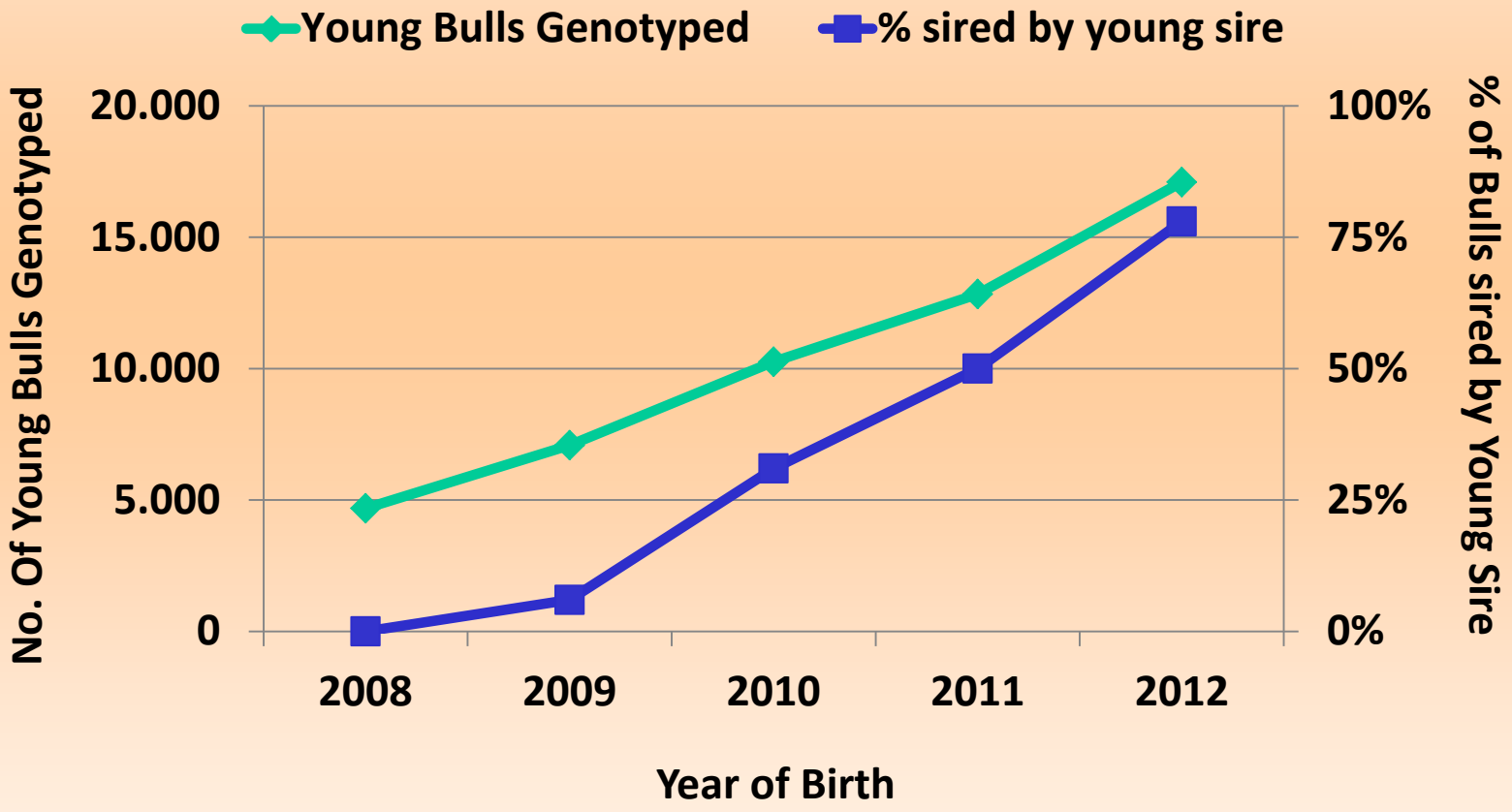
Young genotyped bulls in the North American data base



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Number of Holstein bulls marketed in North America

Year of entry	Number of bulls		
	Traditional progeny testing	Young genotyped bulls	Total
2008	1,798	0	1,798
2009	1,909	337	2,246
2010	1,827	376	2,203
2011	1,441	467	1,908
2012	1,376	555	1,931
Variation	- 23%		+7.4%

Source: USDA

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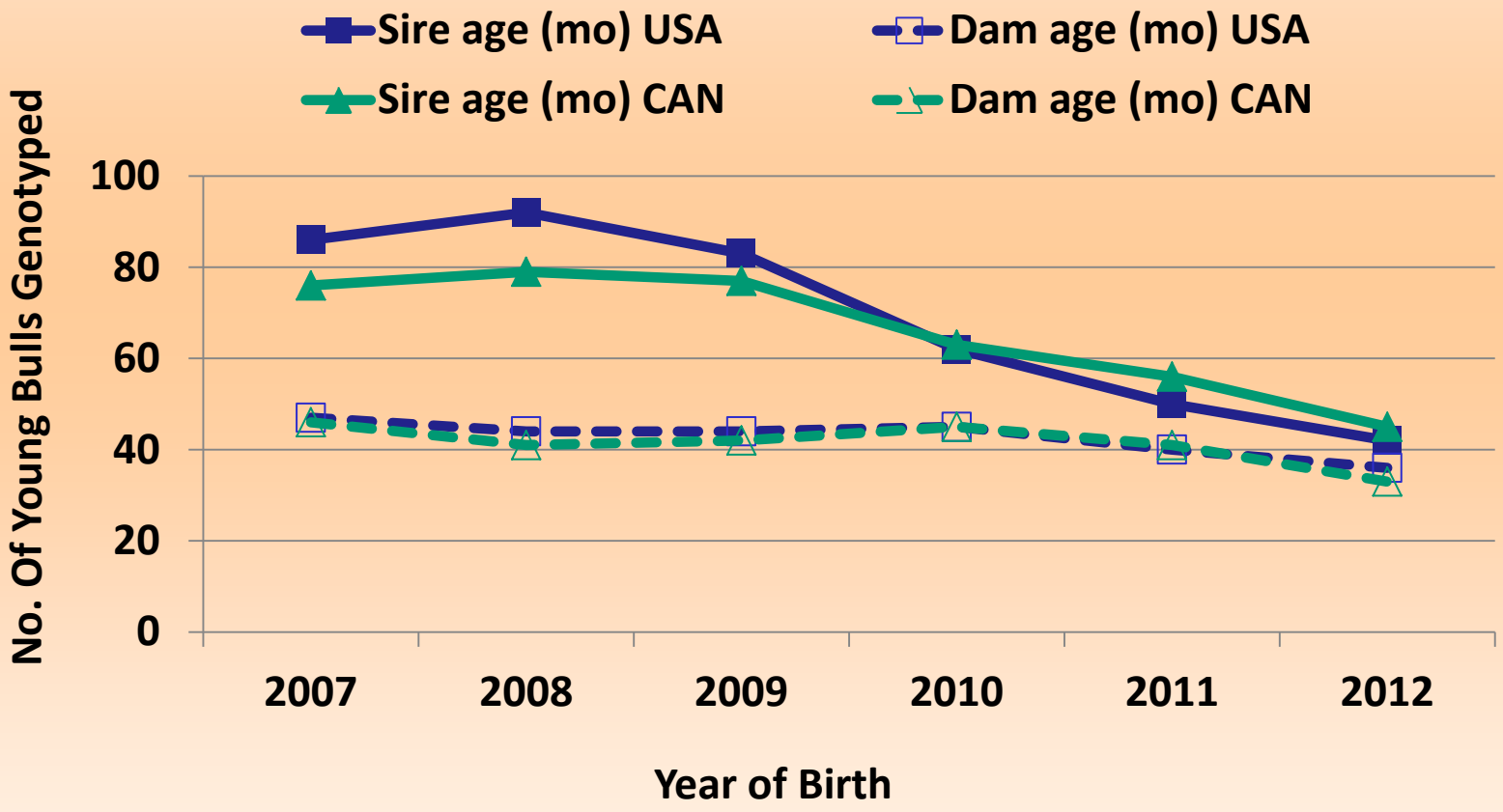
Age of parents of Holstein bulls marketed in US and Canada



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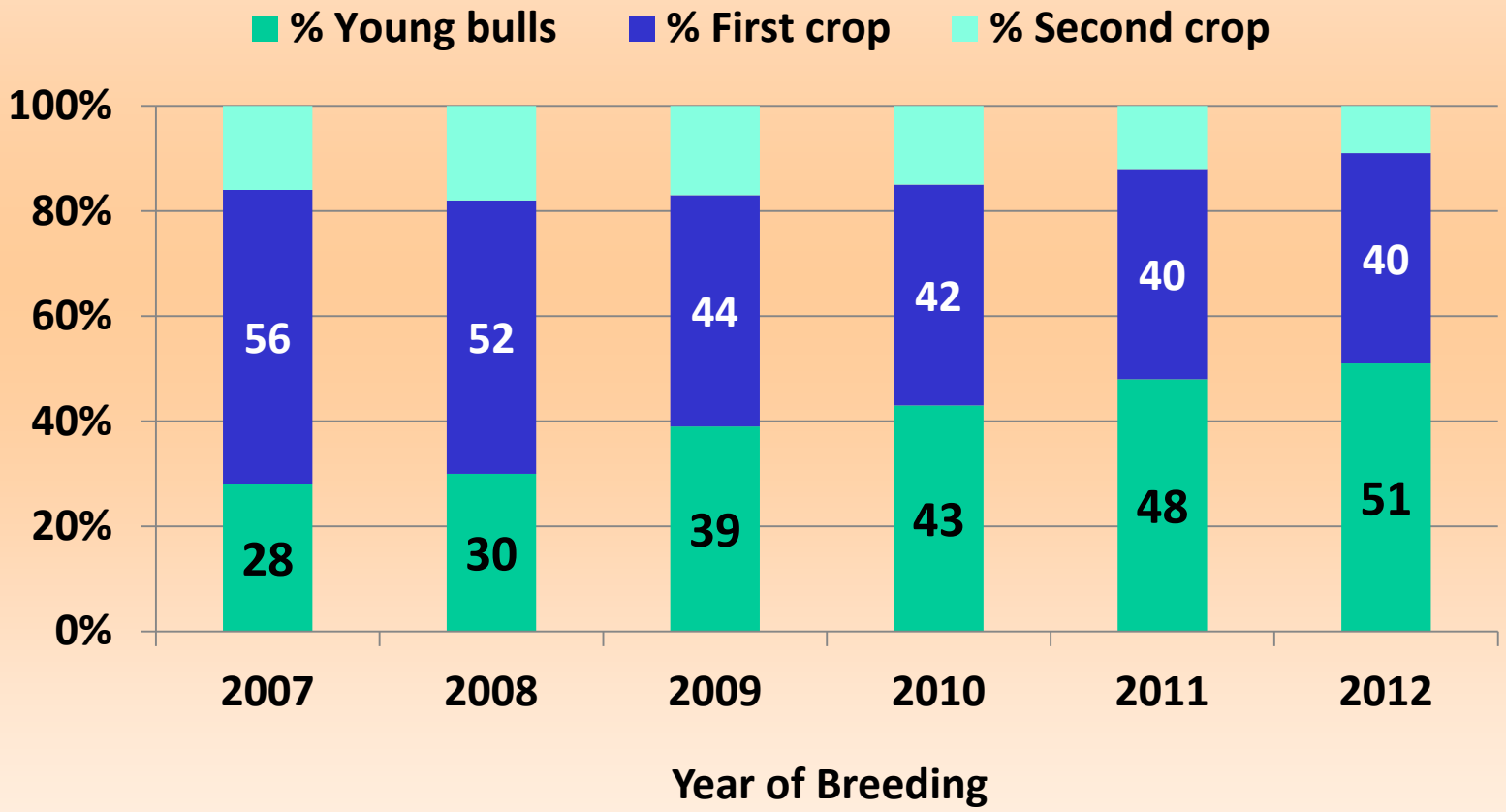
Percentage of breedings by age of Holstein bull in the US



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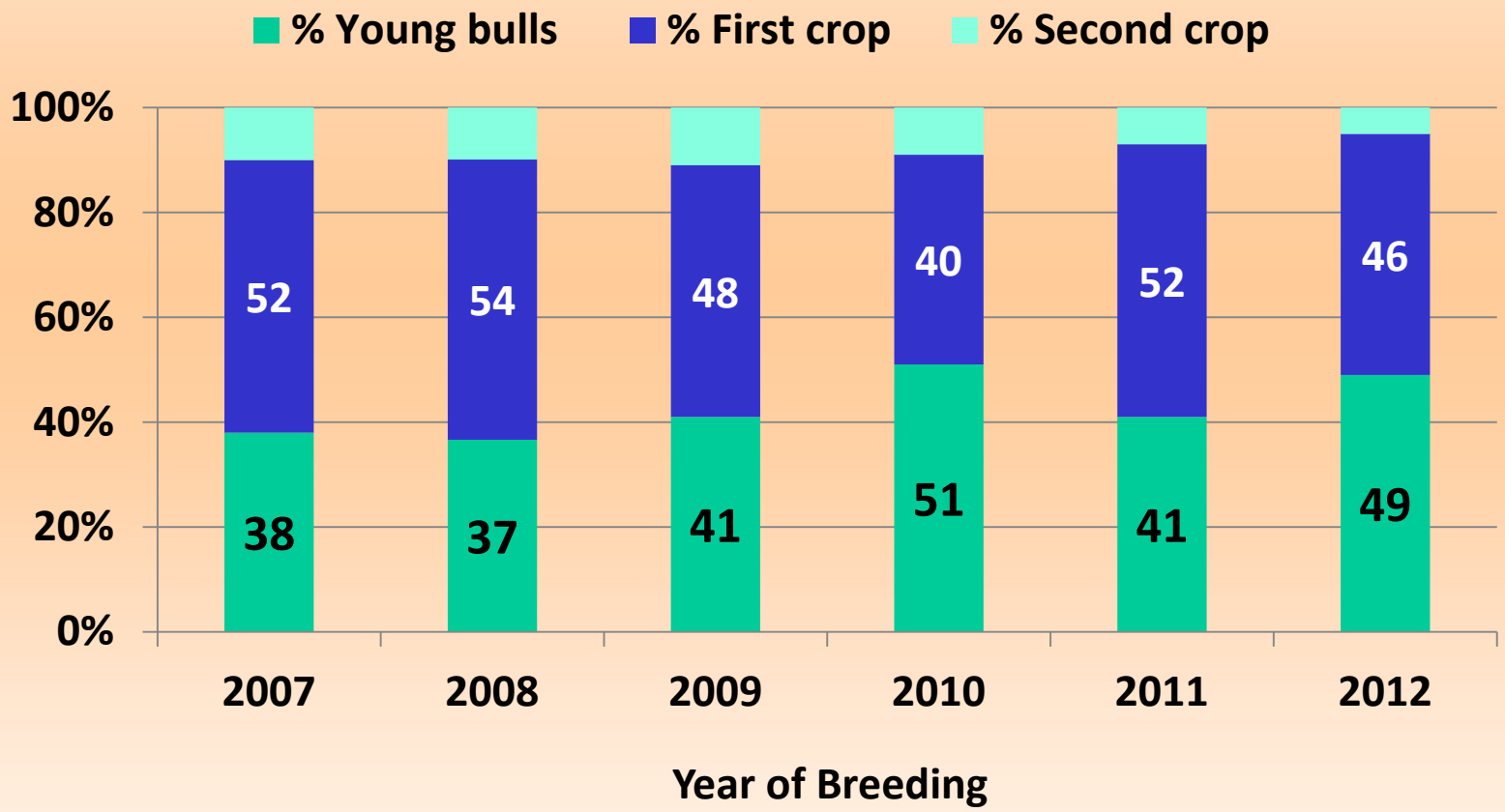
Percentage of breedings by age of Holstein bull in Canada



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Impact on AI industry

- Similar trends in the Jersey breed in terms of the marketing and use of young vs progeny tested bulls
- However, the number of genotyped Jersey bulls is considerably smaller (1,594 genotyped young Jersey bulls born in 2012 vs 17,098 Holsteins)

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Impact on AI industry

- Purchase of females, agreements with breeders
- International alliances to increase reference population size and selection intensity (US, Canada, UK, Italy)
- Impact of opening genomic evaluations to all males (April 2013): too early to tell

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Impact on elite breeders

- About 30% of young males genotyped directly by breeders since April 2013
- Trend towards a smaller number of elite breeders that are investing heavily in genomics
- Prices for top genomic heifers can be very high (e.g., $265,000)

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Impact on breed associations: USA

Year	Number of registrations	Number of classifications (regular)	Number of classifications (SET pgm=AI)
2007	317,128	215,632	110,283
2008	348,128	235,632	116,093
2009	327,622	210,959	114,756
2010	339,908	217,996	97,109
2011	360,149	228,977	85,975
2012	362,669	228,541	88,586

Source: Holstein USA

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Impact on breed associations: USA

- Registrations in the US have kept increasing
- There was a decrease of about 10% from 2007 to 2012 in type classifications in the SET program
- However, SET classifications increased from 2011 to 2012

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Impact on breed associations: Canada

Year	Number of animals registered	Number of animals classified
2009	297,836	240,484
2010	302,650	255,671
2011	298,397	251,219
2012	306,038	253,299

Source: Holstein Canada

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Impact on milk recording agencies

- In the US about 4.3M cows on DHI programs of which 84% are Holstein
- In Canada, about 0.73M cows on DHI of which 95% are Holstein
- Main trend is decreasing herd numbers but increased herd size leading to similar cow numbers on DHI
- DHI data used primarily for herd management
- Limited impact from genomics to date

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Impact on commercial dairy producers

- On the sire side:
  - Higher average genetic merit of available sires
  - Larger choice of sires in terms of traits and semen price
  - More rapid increase in the genetic merit of sires for all traits
  - More inbreeding/homozygosity?

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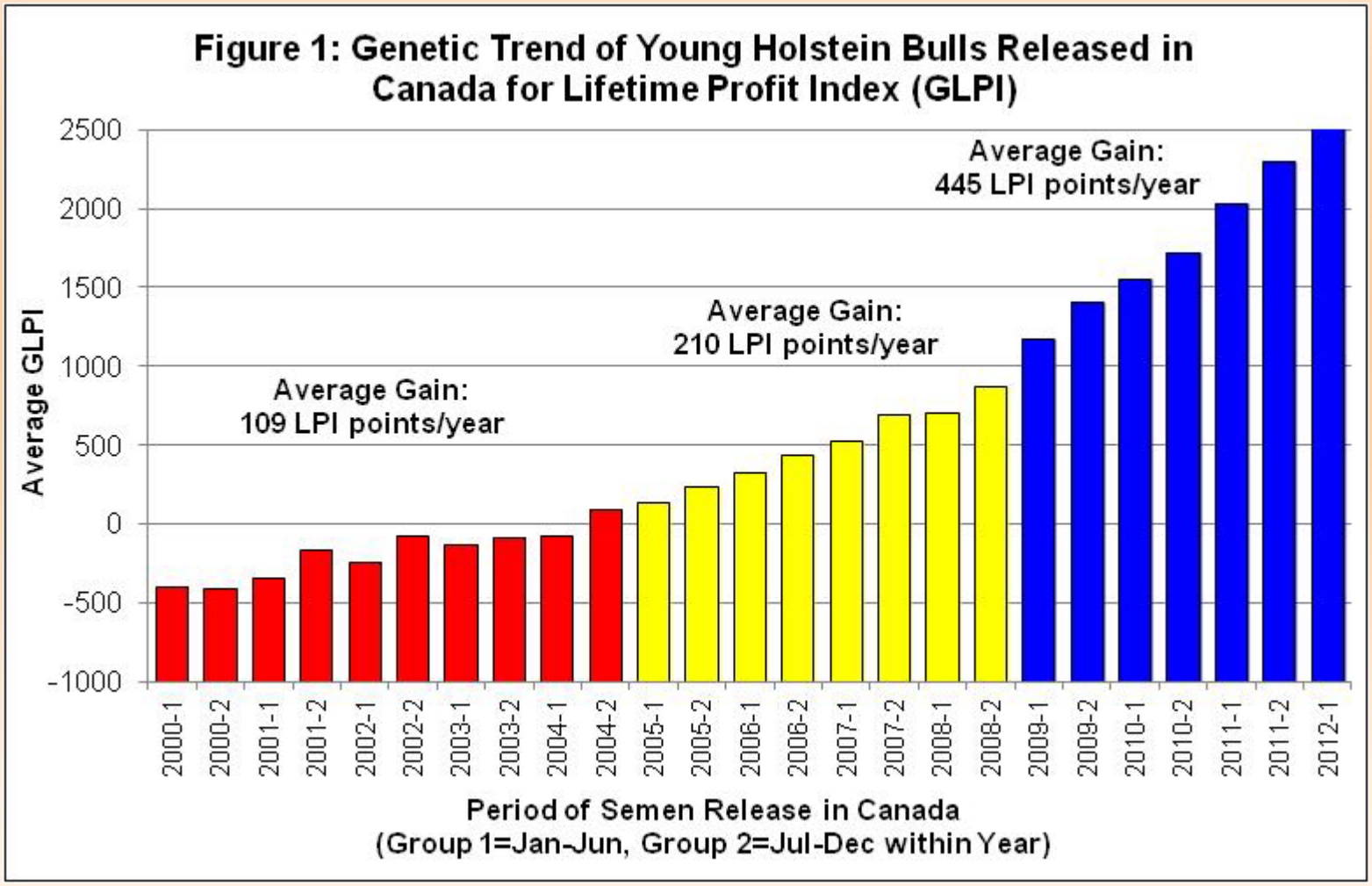
Genetic merit of Holstein bulls marketed in Canada



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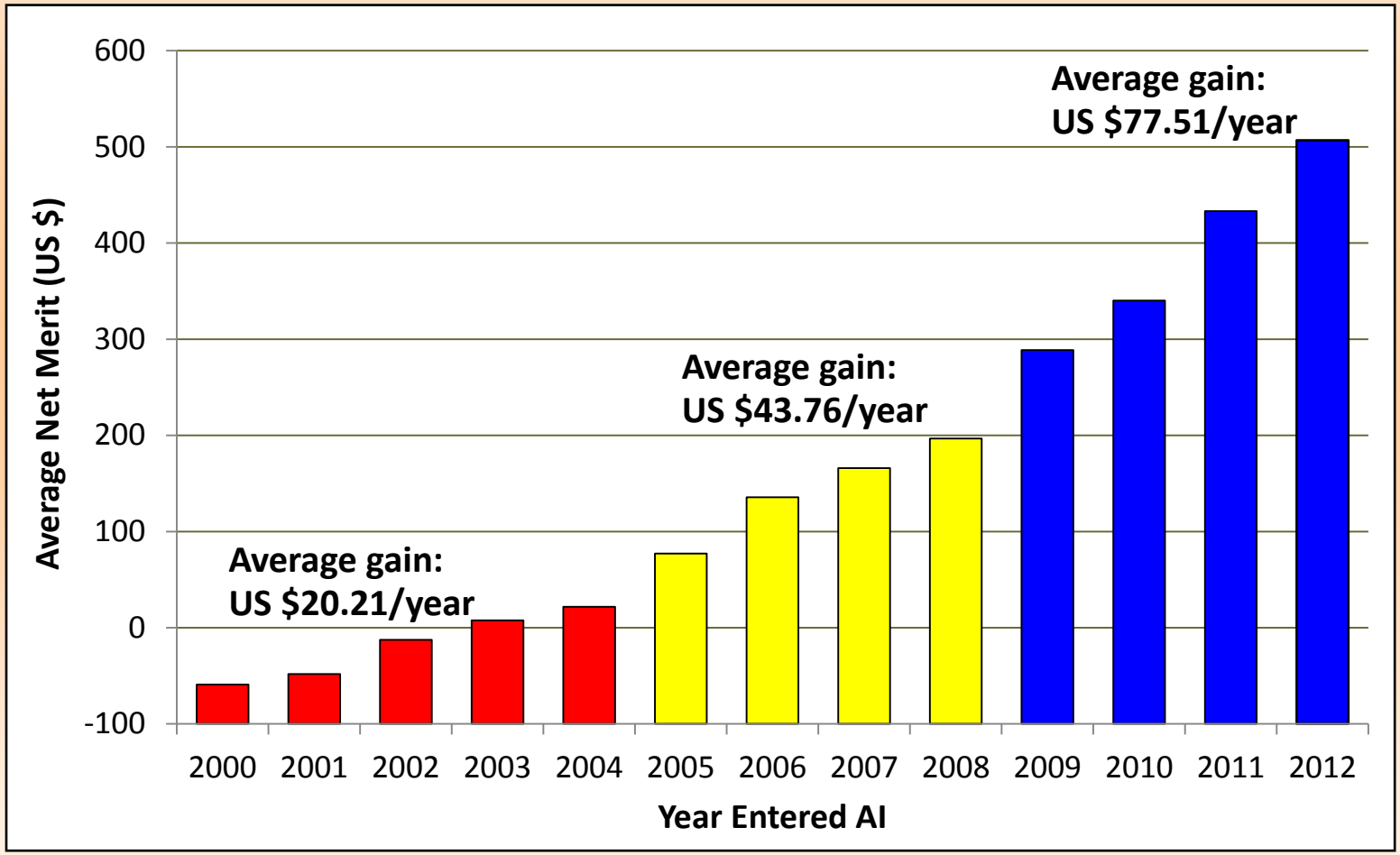

Source: USDA

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Impact on commercial dairy producers

- On the dam side:
  - Genotyping of heifers has been increasing but is still limited currently - about 12,500 per month in North America (average for last 6 months)
  - Uptake dependent on cost and value of genotyping

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Impact on commercial dairy producers

- Multiple uses: parentage verification, genomic predictions, causative mutations, fertility haplotypes, mating strategies
- Synergy with the use of sexed semen and IVF if the cost of this technology becomes manageable

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Impact on dairy producers

Holstein females in North American Consortium database as of August 10, 2013

Chip type	Cows	Heifers	Total
50K or more	18,159	35,207	53,366
LD	29,429	201,704	231,133
Imputed	2,797	1,241	4,038
Total	50,385	238,152	288,537

Source: USDA

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Impact on dairy producers

Jersey females in North American Consortium database as of August 10, 2013

Chip type	Cows	Heifers	Total
50K or more	1,123	977	2,100
LD	11,728	22,607	34,335
Imputed	234	31	265
Total	13,085	23,615	36,700

Source: USDA

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Impact on research organizations

- More work to do:
  - Genomic evaluation methods
  - Sequencing, gene discovery
  - Novel traits
  - Breeding strategies
- A lot more fun!
- But more resources needed

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Some key issues the industry

- Inbreeding, genetic diversity (including across breeds)
- Sequencing, new genes and mutations
- Novel traits, resource populations (feed efficiency, health, milk properties)

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Conclusions

- Genomics: a wind of change in the dairy cattle breeding industry
- So far only incremental changes in the organization of industry structures in North America
- But this is only the beginning!

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Thank you

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Young genotyped bulls in the North American data base

Bull birth year	Number of young Holstein bulls genotyped	% of young bulls with a young sire
2008	4,684	0
2009	7,086	6
2010	10,263	31
2011	12,839	50
2012	17,098	78

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Age of parents of Holstein bulls marketed in the US

Bull birth year	Sire age (months)	Dam age (months)
2007	86	47
2008	92	44
2009	83	44
2010	62	45
2011	50	40
2012	42	36

Source: CDN

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Age of parents of Holstein bulls marketed in Canada

Bull birth year	Sire age (months)	Dam age (months)
2007	76	46
2008	79	41
2009	77	42
2010	63	45
2011	56	41
2012	45	33

Source: CDN

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Percentage of breedings by age of Holstein bull in the US

Year of breeding	% Young bulls	% First crop	% Second crop
2007	28	56	16
2008	30	52	18
2009	39	44	17
2010	43	42	15
2011	48	40	12
2012	51	40	9

Source: USDA

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Percentage of breedings by age of Holstein bull in Canada

Year of breeding	% Young bulls	% First crop	% Second crop
2007	38	52	10
2008	37	54	10
2009	41	48	11
2010	51	40	9
2011	41	52	7
2012	49	46	5

Source: CDN

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