Cost and benefit evaluation of genomic selection in Canadian swine breeding schemes

Canadian Centre for Swine Improvement

CCSI CCAP

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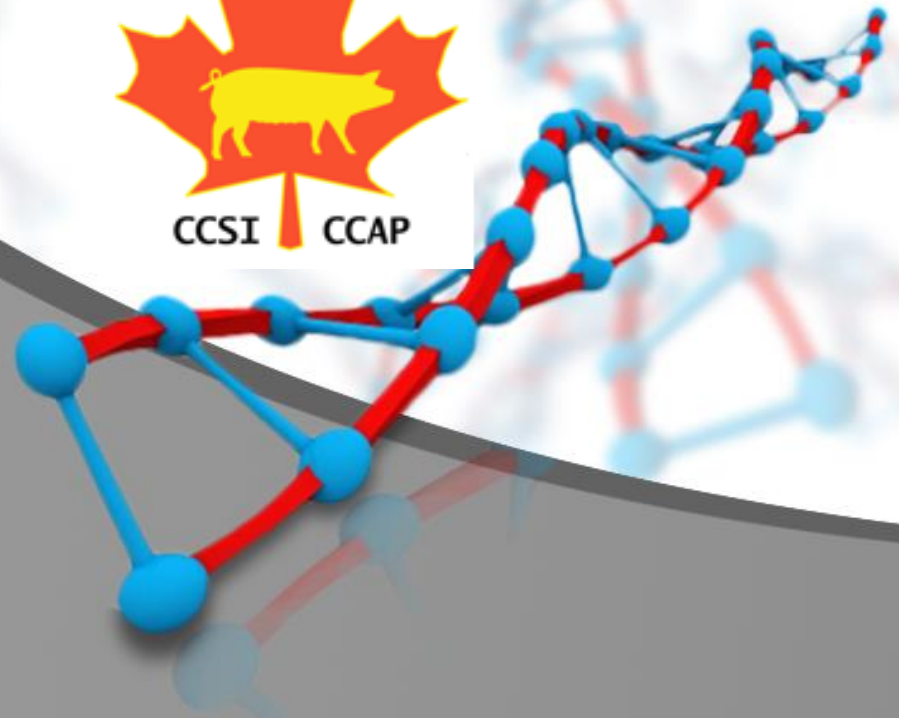


EAAP
European Federation of Animal Science

Introduction

- Genomics should bring more benefit than cost
  - Higher selection accuracy ⟶ Higher genetic gain
  - Additional costs mainly due to genotyping of animals
- There are many questions for implementation, such as:
  - Which animals to genotype?
  - Who pays and who benefits?

Objective

- To investigate the net economic gain of genomic selection compared to traditional selection

Methods for evaluation of costs and benefits

- Potential increase in genetic gain based on simulation study of Lillehammer et al. (2013)
  - Simulation was for a 600 Landrace sow nucleus with 1,200 litters tested per year
  - Compared six scenarios for implementation of the genomic evaluation
    - ✓ Either one or two station-tested boars per litter were genotyped
    - ✓ Zero, one or two gilts per litter were genotyped
    - ✓ Depending on the genotyping scenario, genetic gain increased from 13% to 55%
- For our study, the genotyping costs and economic benefit were evaluated for each scenario under a Canadian context

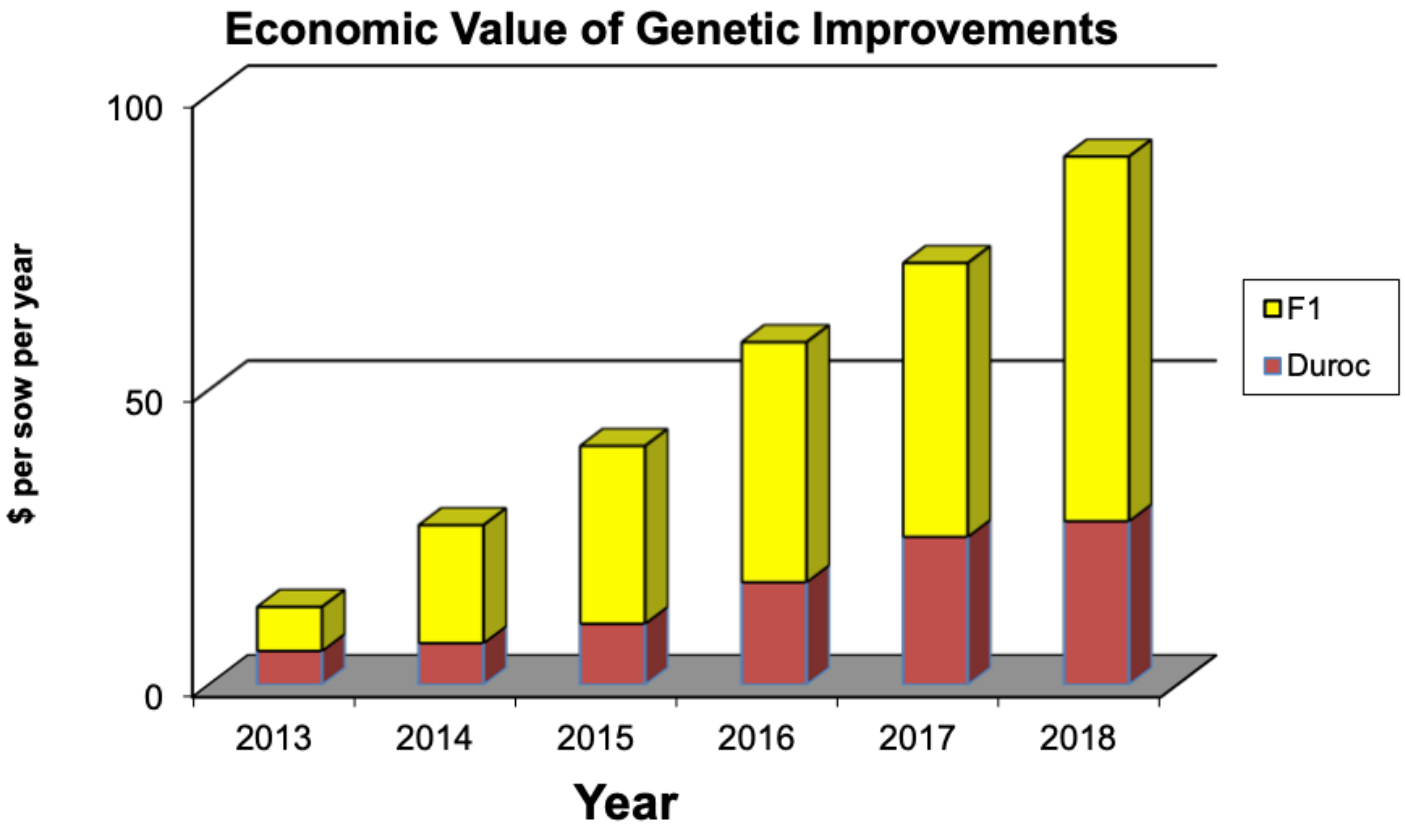
Genetic gain and genotyping cost for each scenario (Scenario 0 is pre-genomics)

Genotyping Scenario	#Genotyped			Genetic change		Cost
	Females per litter	Males per litter	Total	Absolute change	Relative gain	$25/panel
0	0	0	0	0.62	0	0
1	0	1	1,200	0.70	13%	$30,000
2	1	1	2,400	0.79	28%	$60,000
3	2	1	3,600	0.87	40%	$90,000
4	0	2	2,400	0.76	23%	$30,000
5	1	2	3,600	0.88	42%	$90,000
6	2	2	4,800	0.96	55%	$120,000

Economic analysis

- Genotyping costs occur at the nucleus while benefits are spread across nucleus, multiplication and commercial levels (even packers!)
  - The cost of 50K SNP genotyping is $25 Canadian per animal
  - Economic benefit a combination of:
    - ✓ Increased genetic gains (Lillehammer et al. 2013)
    - ✓ Canadian economic values (CCSI annual report 2018)

Economic value of genetic improvements



Average value of genetic improvement in the past 6 years in Canadian maternal lines (Yorkshire and Landrace) was ~$13 per sow per year

(CCSI annual report, 2018)

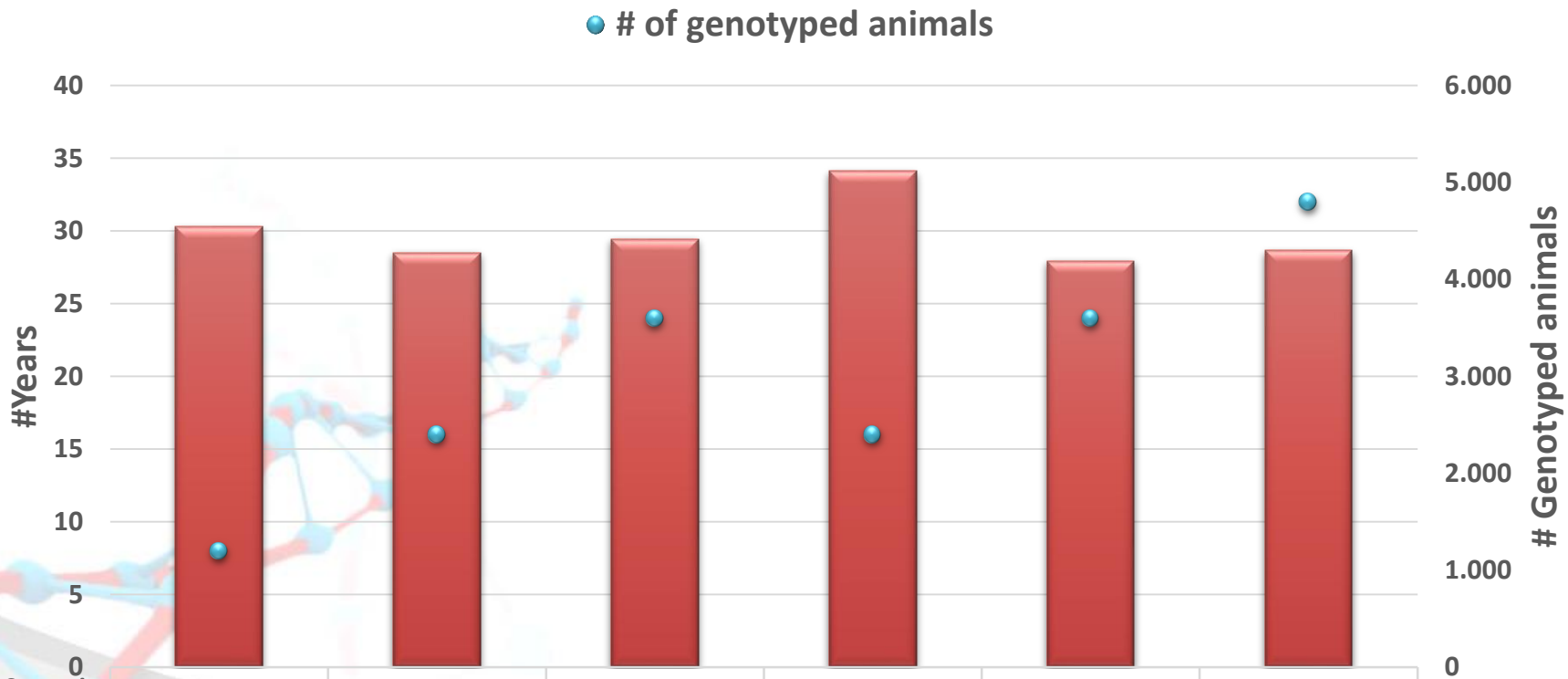
Economic benefit calculations

- Average gain in last 6 years of ~$13 / sow per year
  - Multiply by the percent increase in gain to get benefit / sow
  - Multiply by the number of sows to get total annual benefit
  - Assume for each nucleus sow that there are 10 multiplier sows and 100 commercial sows

Example calculation of economic benefit

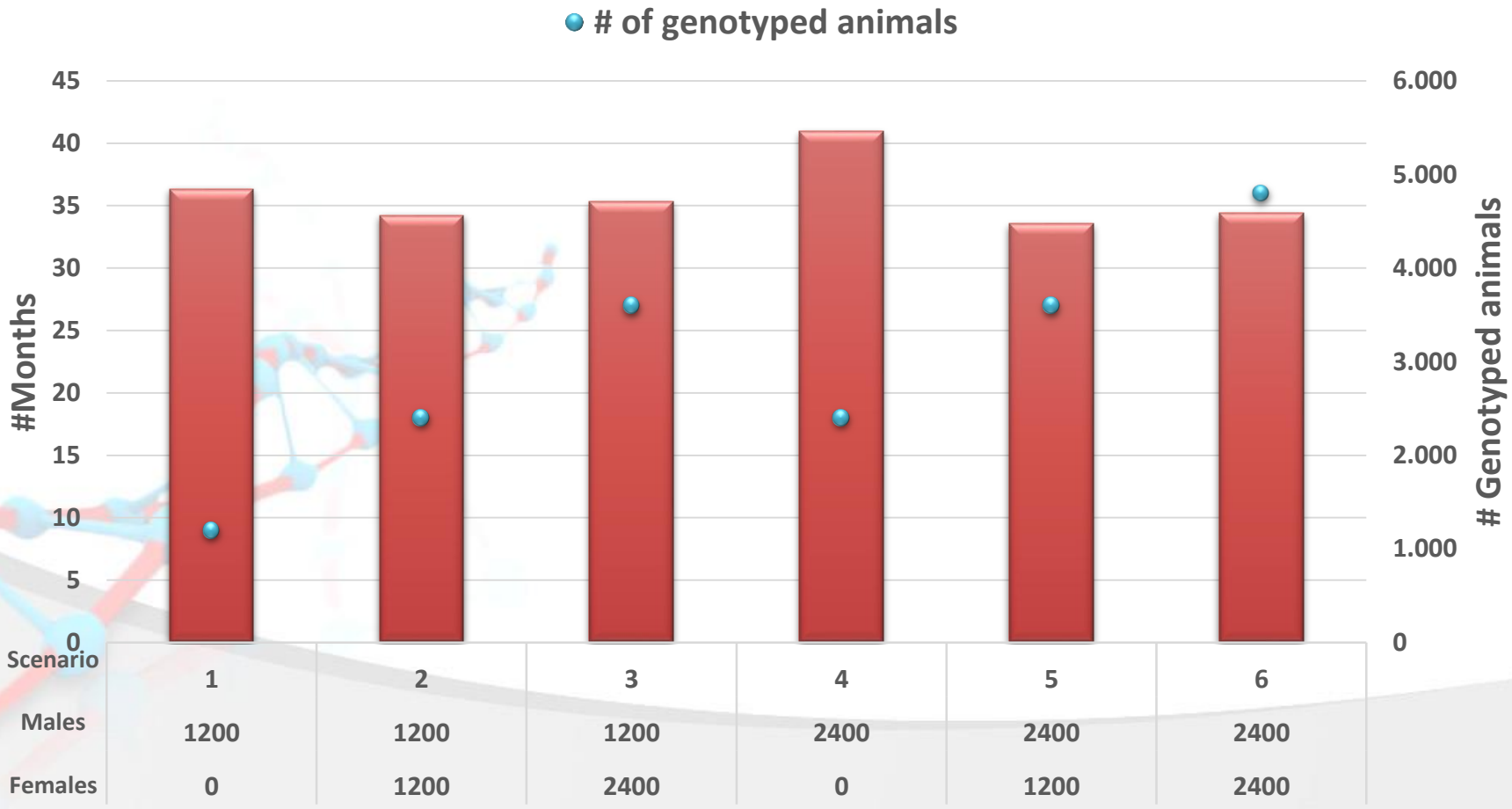
- For a 40% increase in genetic gain (scenario 3), benefit will be:
  - 40% of $13 = ~$5 per sow per year
- Total annual benefit will be:
  - $3,000 for 600 nucleus sows;
  - $30,000 for 6,000 multipliers sows; and
  - $300,000 for 60,000 commercial sows
- Costs of genotyping are subtracted to give net benefit for each scenario

At the nucleus level the pay back is in YEARS



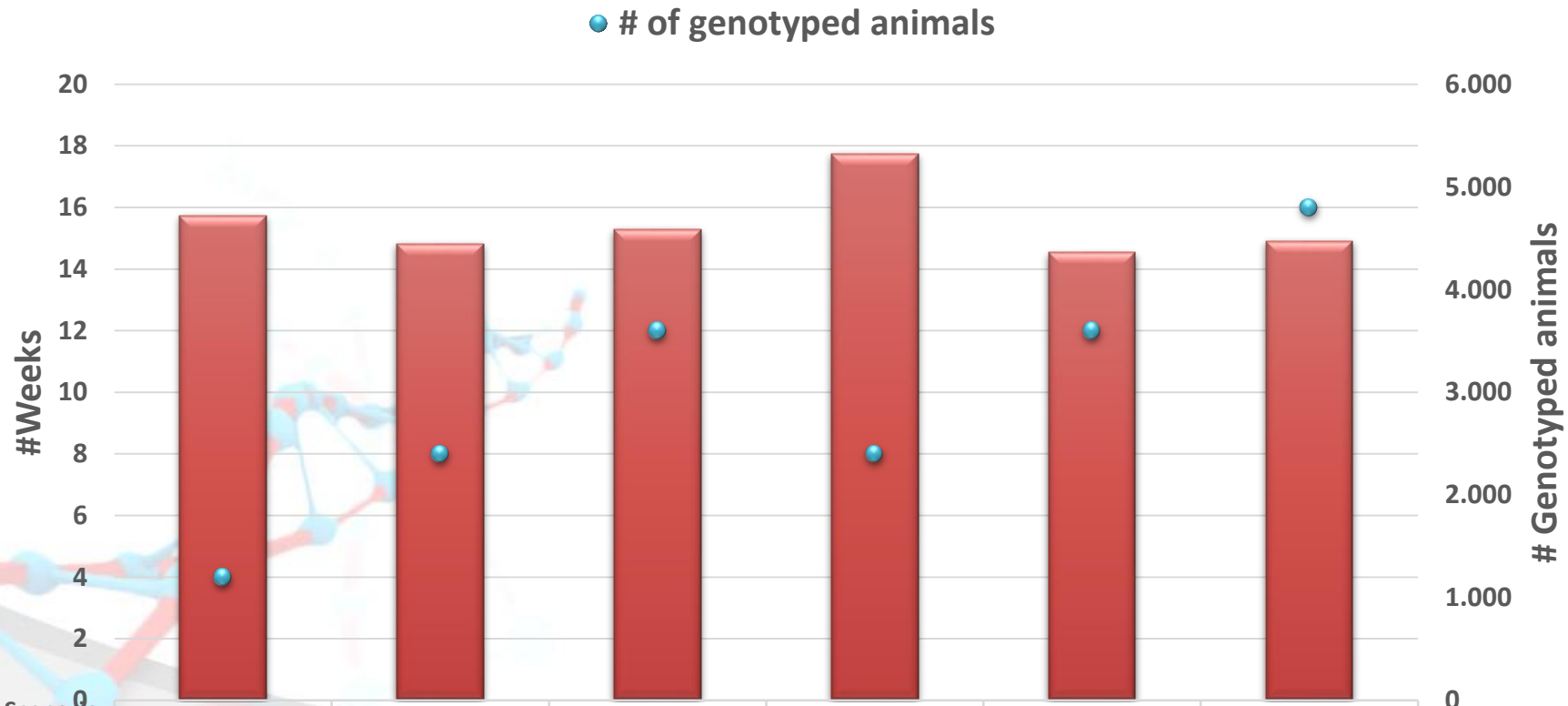
Scenario	1	2	3	4	5	6
Males	1200	1200	1200	2400	2400	2400
Females	0	1200	2400	0	1200	2400

At the multiplier level the pay back is in MONTHS



Scenario	1	2	3	4	5	6
Males	1200	1200	1200	2400	2400	2400
Females	0	1200	2400	0	1200	2400

At commercial level the pay back is in WEEKS



Scenario	1	2	3	4	5	6
Males	1200	1200	1200	2400	2400	2400
Females	0	1200	2400	0	1200	2400

Validation studies are in progress

- Ranking animals based on GEBV vs. EBV
- Compare to future phenotypes
- Example: Females selected in 2017 based on GEBV rather than EBV had significantly more piglets born per litter
- For litter size this corresponded to an increase in genetic gain of more than 50%

Conclusion and Implications

- When traditional selection was replaced by different scenarios of genomic selection:
  - Nucleus herd benefit is POOR (pay back in 28 to 34 years)
  - Multiplier herd benefit is GOOD (pay back in 34 to 41 months)
  - Commercial herd benefit is VERY GOOD (pay back in 15 to 18 weeks)
- These calculations should be discounted for genetic lag and present value of future returns (although it won't change these conclusions)
- Costs of investment in genomics need to be shared beyond the nucleus, at least to the multiplier level

This study is part of a larger project: Chips for better chops

Integrating genomic information into current genetic evaluation programs to produce more efficient, higher quality hogs and pork

Adaptability to market needs and opportunities with genomic tools to target traits important to buyers of Canadian pork

UNIVERSITÉ LAVAL

HyLife™

Fast genetics™

OLYMEL

ALPHAGENE

Canadian Centre for Swine Improvement

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Thank you!