

SNP Technology and Herd Improvement

NSERC RFI Producer Day
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UNIVERSITY OF
ALBERTA

Livestock Gentec and UofA

- Livestock Gentec; Alberta Innovates Bio Solutions center
- Carry out and capitalize on world-class genomics research
- Commercial benefits to the Canadian livestock industry
- Created out of the Agriculture Food and Nutritional Science faculty at UofA



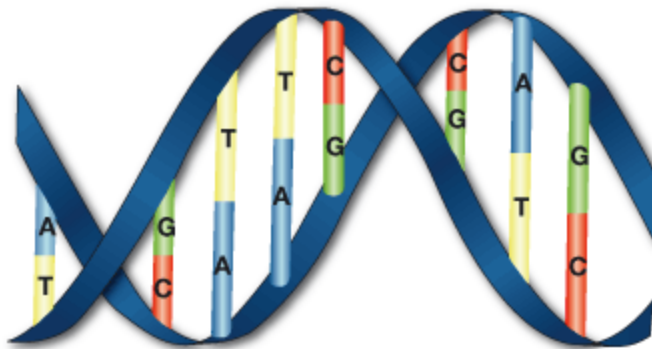


Genetics and Genomics

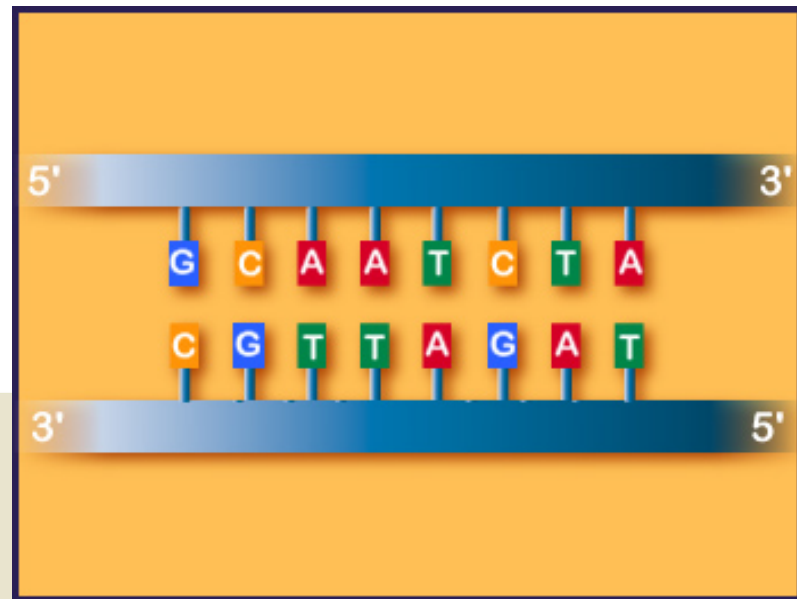
- **Genetics** - the study of inheritance
- **Animal breeding** - using knowledge of genetics to improve animals
- **Genomics** – branch of molecular biology concerned with the structure, function, evolution, and mapping of genomes

What is Genomics?

- Everyone has a DNA code
- Depending on that code, it will dictate what you will look like, good at sports, musical, etc.
- The code is made up of 4 letters, A, G, C and T and come in pairs



Thymine (Yellow) = T Guanine (Green) = G
Adenine (Blue) = A Cytosine (Red) = C





Genomics, DNA, and Markers

- “As easy as ACGT” - the 4 letters of the genetic code

animal 1

A C G T A C G T

animal 2

A C G C A C G T

this difference is a Single Nucleotide Polymorphism or “SNP Marker”

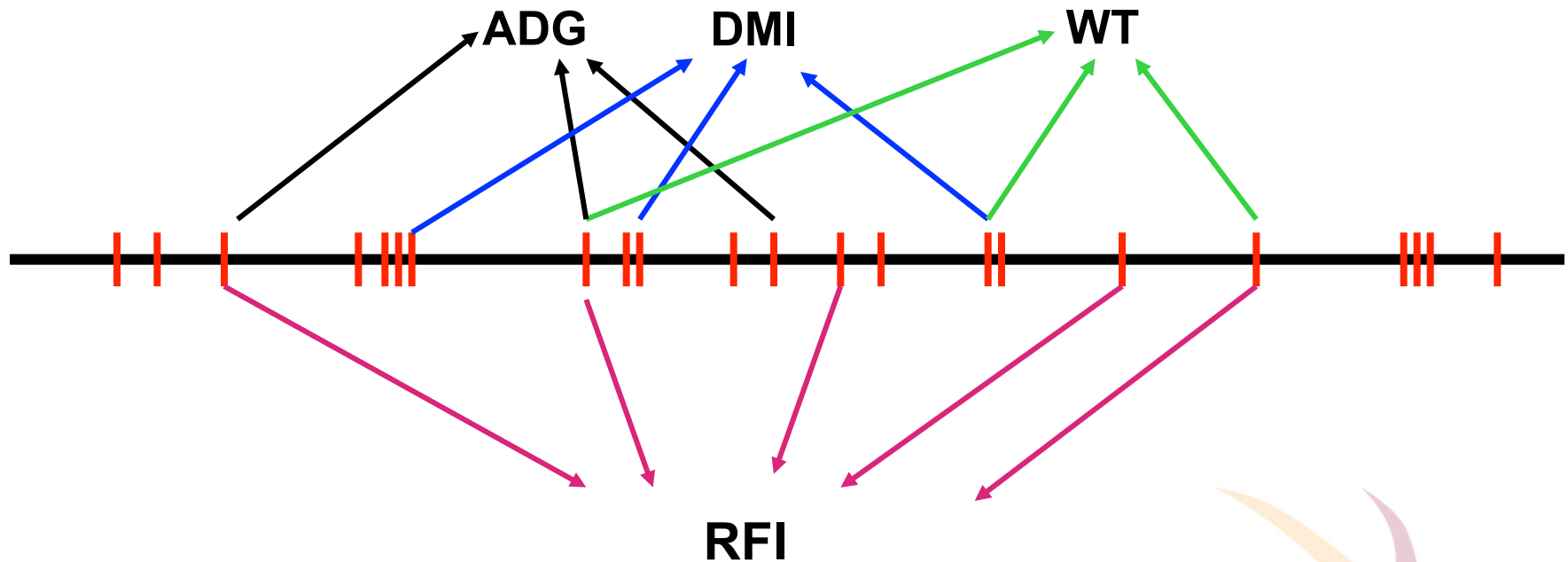


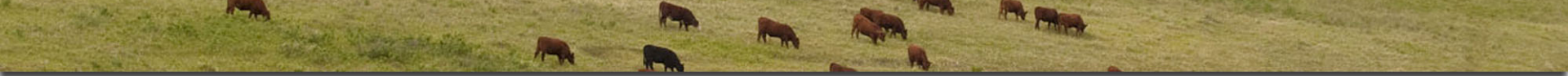
Genomics, DNA, and Markers

- Generate or increase accuracies of predictions
- Densities....400 (ca.), 6K, 50K, 770K (genome ~3bn)

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“Prediction is very difficult,
especially about the future”

Niels Bohr, Physicist





Genomics' Influence

$$\Delta G = i \cdot r \cdot \sigma_a / L$$



Where;

ΔG is genetic gain

i is selection intensity

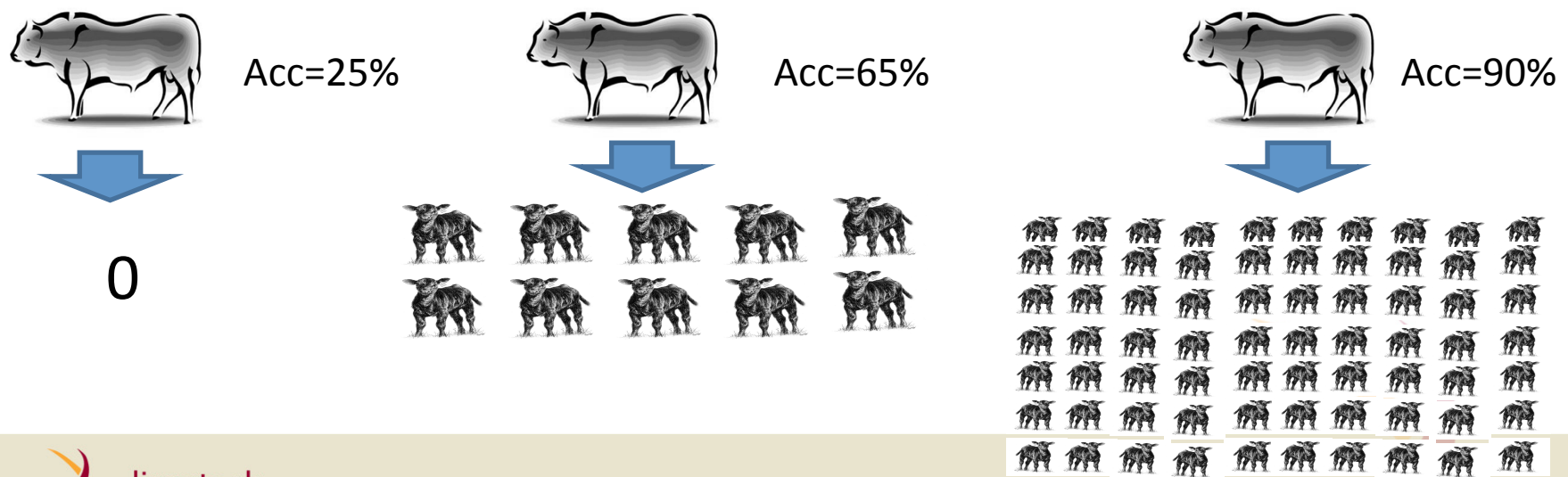
r is selection accuracy

L is generation interval

σ_a is genetic SD

How important is accuracy?

- *Caveat Emptor*
- Pre-genomics, accuracy is accrued through progeny recording (and records of relatives)

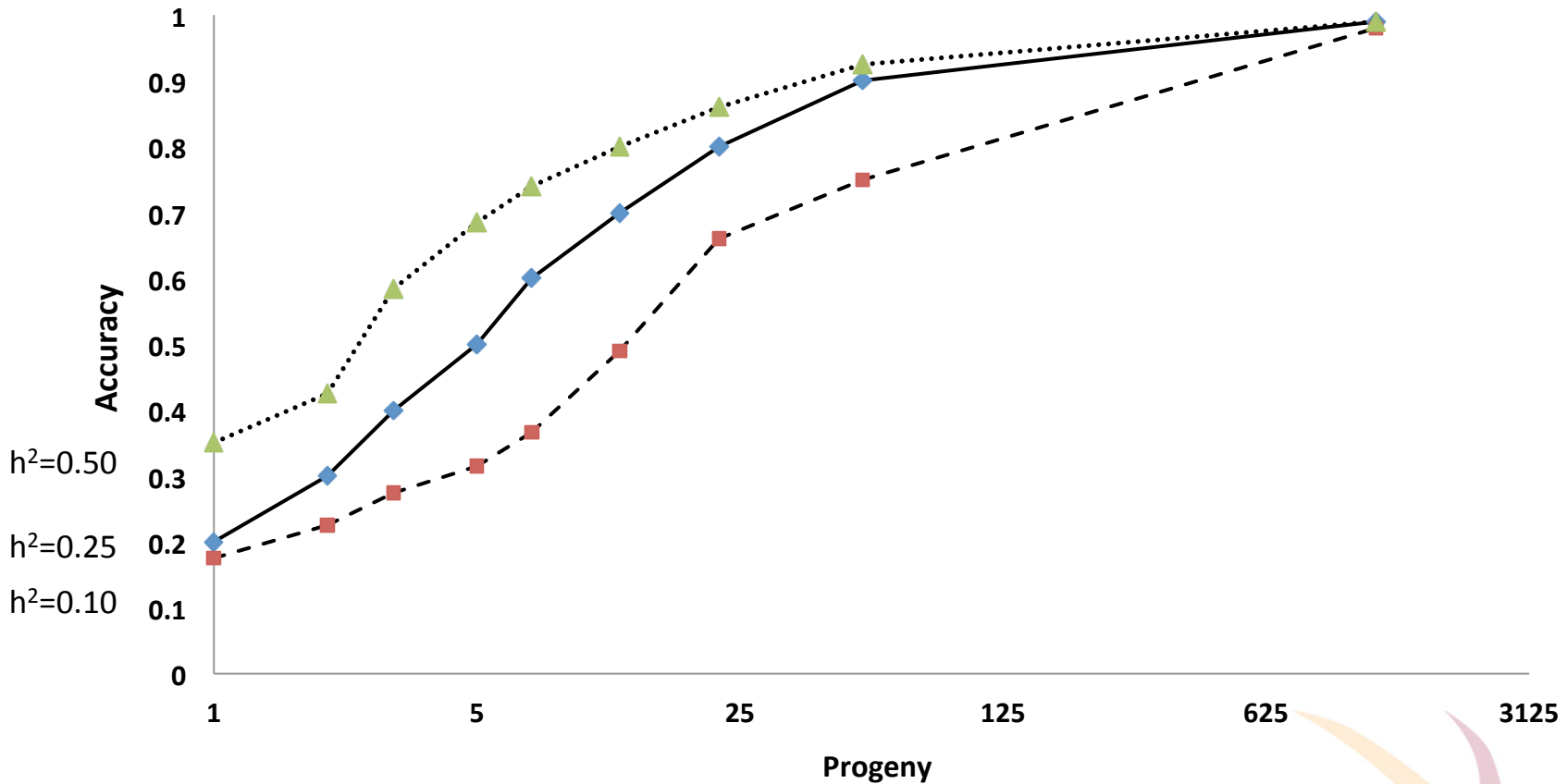




Possible EPD changes

Accuracy %	Birth Wt	Wean Wt	Milk
10	±2.4	±10.4	±8.7
30	±1.8	±8.1	±6.8
50	±1.3	±5.8	±4.9
75	±0.8	±2.9	±2.4
90	±0.3	±1.2	±1.0

Progeny increases accuracy

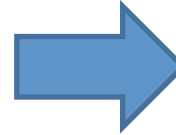
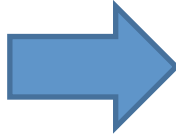




How important is accuracy?

- Always look at the accuracy!
- Outside genomics, accuracy is increased by
 - More phenotypes
 - Better quality phenotypes
 - Better pedigree recording

Genomics' Influence

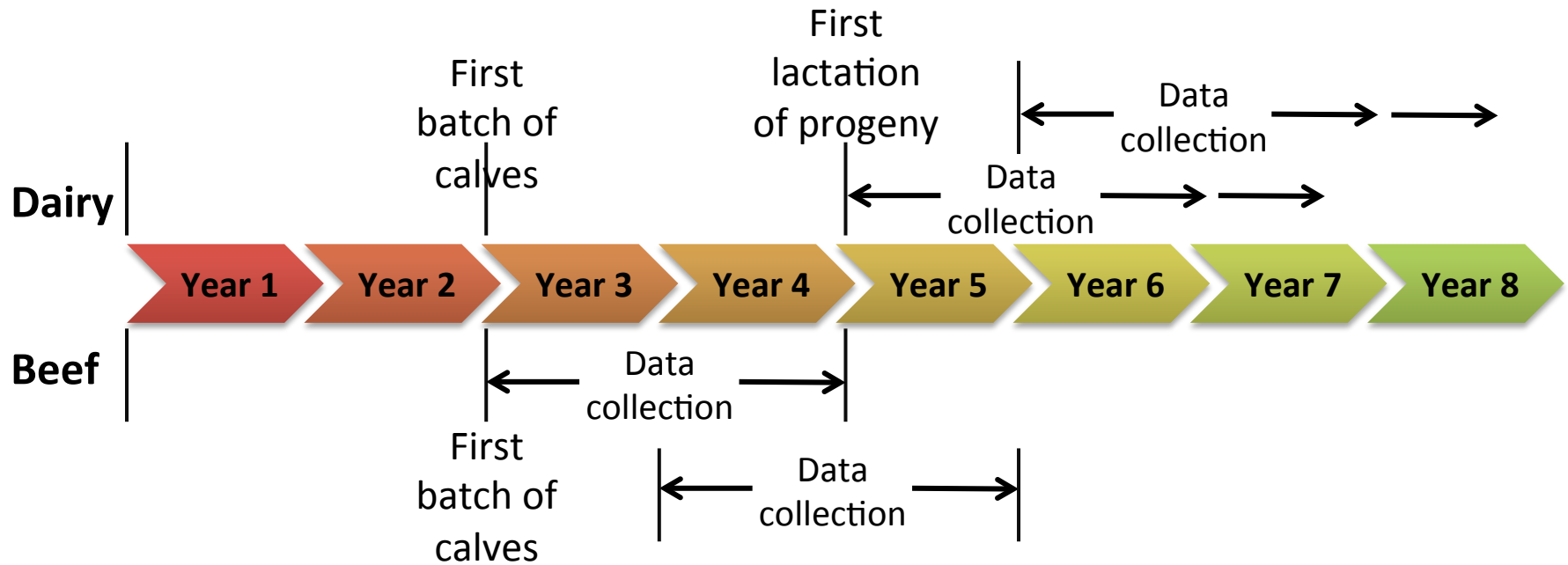




Genomics' Influence

Trait	Progeny Equivalent
Birth Wt	10
Weaning Wt	16
Yearling Wt	22
Feed Efficiency	15
Milk	12
Carcass Wt	7
Ultrasound Backfat	28

Genomics' Influence

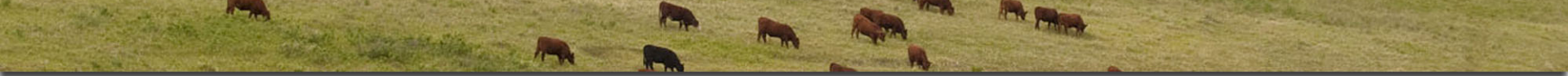




Genomics' Influence

Also

- Difficult to measure traits
- Sex limited traits
- Expensive to measure traits
- Terminal traits



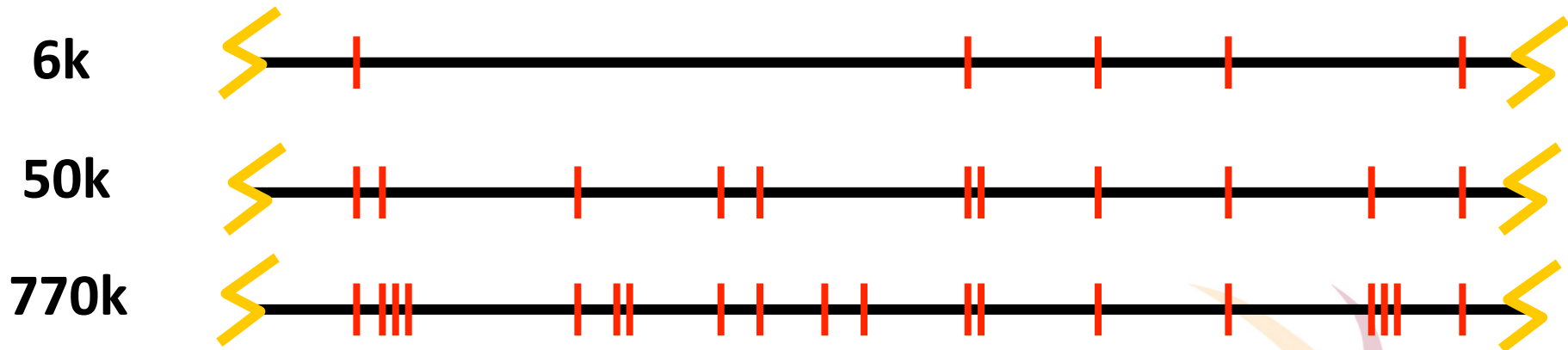
Genomics tools

- The SNP Chip
- Genomically enhanced EPDs (GE-EPD)
- Molecular Breeding Value (MBV)
- Marker Assisted Management (MAM)



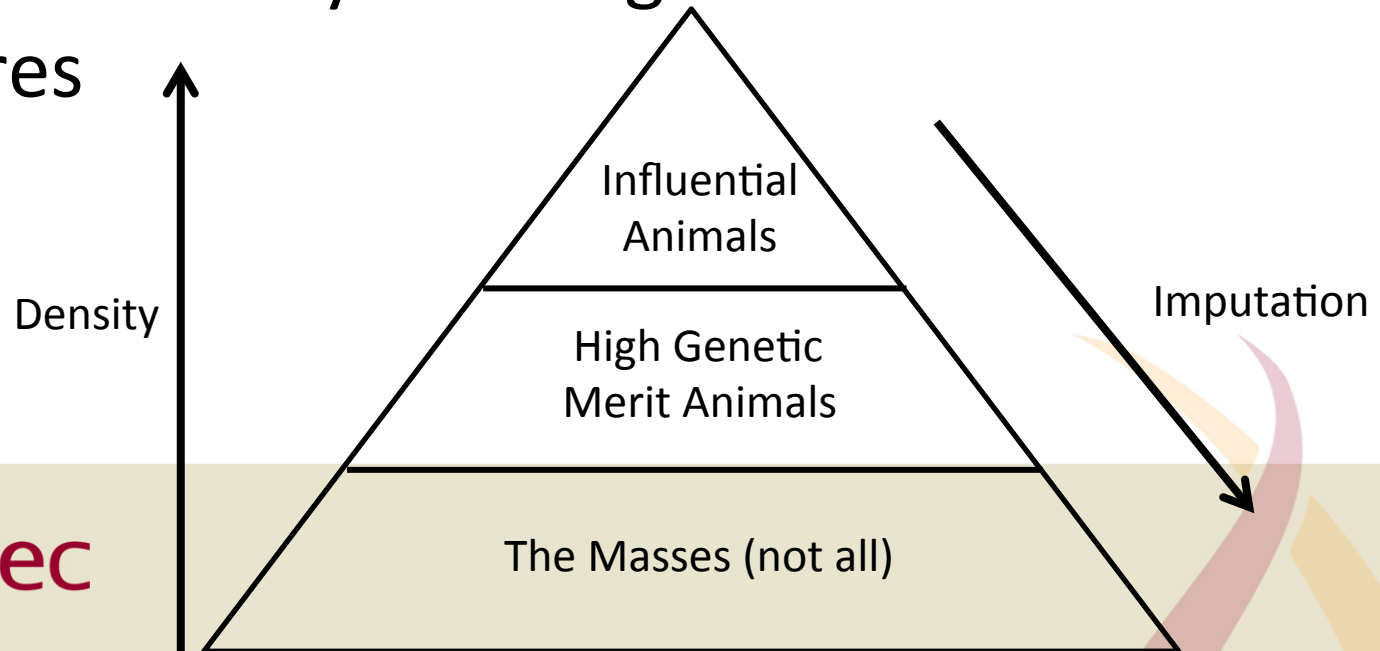
The SNP Chip

- Different densities e.g. 6k, 50k, 770k etc.
 - 3bn base pairs
 - ~30m SNP



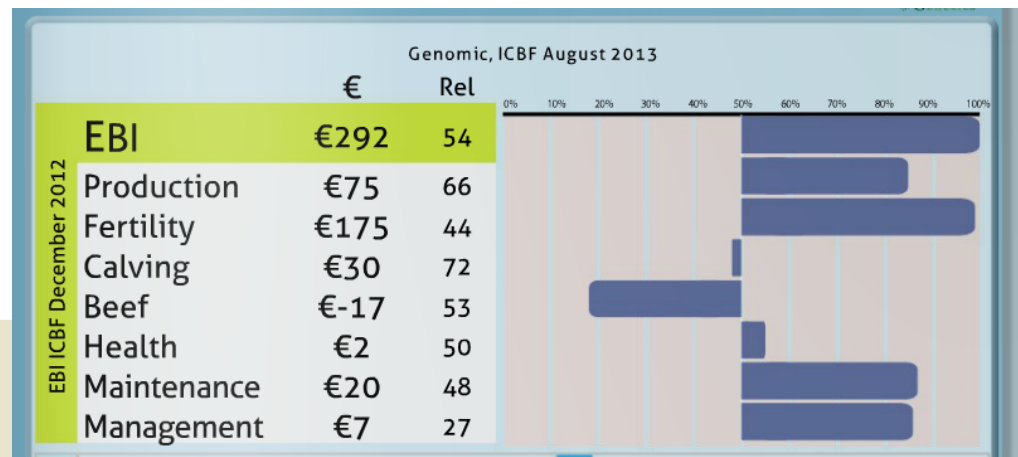
The SNP Chip

- Strategic use of densities
- Higher densities on influential animals
- Lower densities can be imputed
- E.g. low density on slaughter animals with HD on sires



GE-EPDs

- Does exactly what it says on the tin
 - Traditional breeding value complimented by genomic information (blended pedigree)
 - Delivered the same way as EPD
 - Notice the increase in accuracy





GE-EPDs

- Where can I find them?
 - Usually flagged in sales/AI catalogues
- How do I get them?
 - Genotype
 - Work with breed association or other 3rd party
 - Not just for bulls

MBVs

- Different to an GE-EPD
- Animals lacking pedigree
- Utilises genomics only
- Presented just like EPD
- Relative to the discovery pop.

Discovery population(s)



+



	€	Rank
EBI	€292	34
Production	€75	44
Fertility	€175	44
Culling	€20	72
Beef	€-17	53
Health	€2	50
Maintenance	€20	48
Management	€7	27





MBVs

- Where can I find them?
 - Should be indicated in sales/AI catalogues
- How do I get them
 - Provided by some genotyping companies
 - Opportunity for breed associations
 - Make sure you know how to read them i.e. what they are relative to and be cognizant of accuracy

Marker Assisted Management

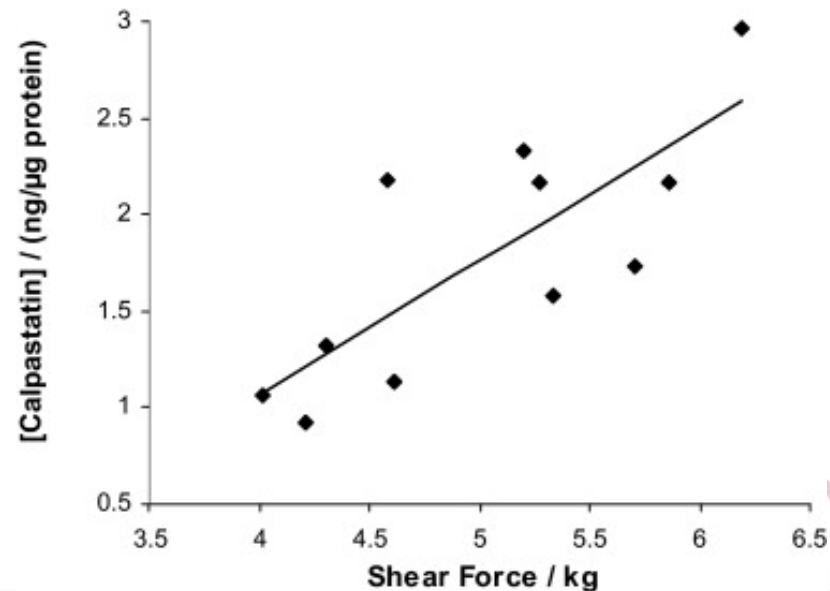
- Parentage
- Control inbreeding
- Single Gene Testing and Lethal recessives
 - Horned/Polled
 - Myostatin (Double muscled)
 - Arthrogryposis multiplex (AM; curly calf)
 - Pulmonary Hypoplasia with Anasarca (PHA)
 - Idiopathic Epilepsy (IE)
 - Contractural Arachnodactyly (CA; fawn calf)
 - Neuropathic Hydrocephalus (NH)





Marker Assisted Management

- Sorting and direct management
 - Based on growth rates (supply management)
 - Appropriate diets
 - Tenderness





Marker Assisted Management

- Mate allocation
 - Can be done using pedigree
 - Can be enhanced by genomics (theory is there but computationally intensive)
 - Iterate possible matings and choose best EPD with inbreeding $<6.25\%$



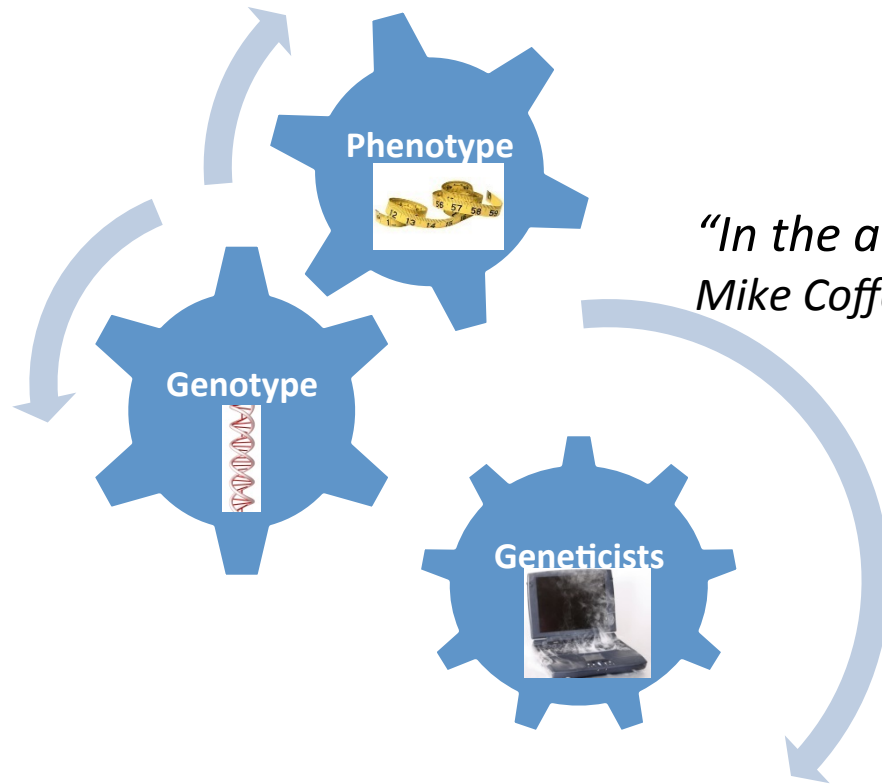
Potential uses of genomic information for beef sectors

ONLY THESE SECTORS PRODUCE NEW ANIMALS

Use	Seedstock	Commercial	Feedlot	Processor
DNA-assisted selection	X	X		
Parentage	X	X		
Recessive allele testing	X	X		
Control of Inbreeding	X	X		
Mate selection	X	X		
DNA-assisted management	X	X	X	
DNA-based purchasing			X	X
Product differentiation				X
Traceability				X

Source: Van Eenennaam, 2012

Phenotypes...they're important!



*“In the age of the genotype, phenotype is king”
Mike Coffey, SRUC*

Genomic ICBF August 2013	
	€ Rel
EBI	€292 54
Production	€75 66
Fertility	€175 44
Calving	€30 72
Beef	€-17 53
Health	€2 50
Maintenance	€20 48
Management	€7 27



How are results generated?

- GBLUP
 - Expectations often deviate due to
 - Non-random mating
 - Unequal allele frequencies
 - Genetic drift
 - Pedigree errors
 - No Pedigree

How are results generated?

- Summation of SNP/haplotype effects

SNP/Haplotype	Wean Wt
1	-2
2	-1.5
3	+4.2
4	+0.6
.	.
.	.
.	.
n	+42

“Functional Genomic Selection”

- Regions that cause difference
- Quantitative Trait Variant (QTV)

50 QTV	Train Multibreed, Validate Purebred	Train in Purebred, Validate Multibreed
Just QTV	0.95	0.96
50k (w/o QTV)	0.39	0.42

*Simulated phenotypes from real 50k

Kizilkaya et al. JAS 2009

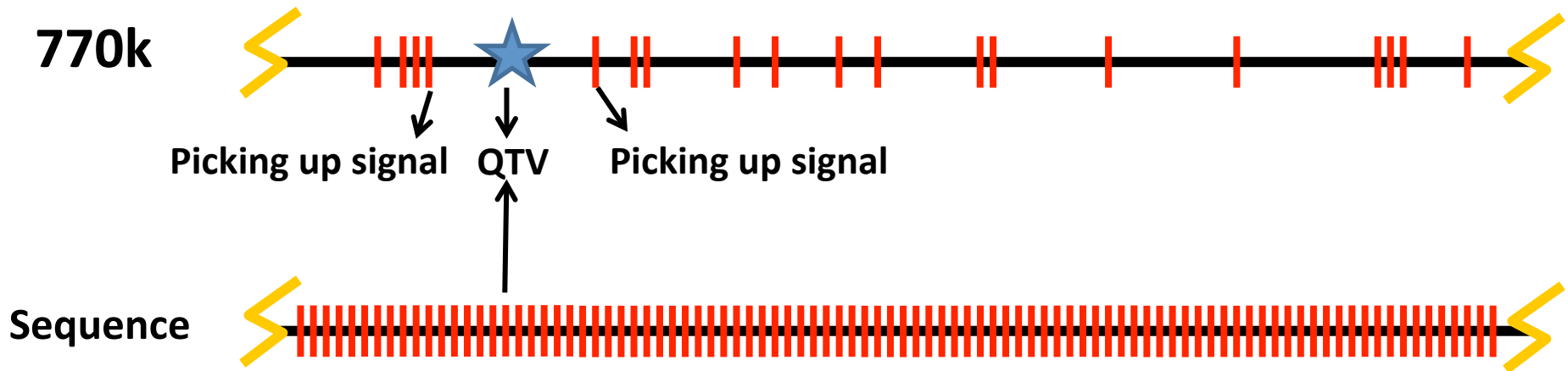


Sampling

- Blood
- Tissue
- Semen
- Hair
- Nasal
- Genotype quality will be affected
- Don't waste time and money
- Contact us for sampling kits

Whole Genome Sequence

- Filling in the blanks





Conclusion

- Depending on who you are, different tools are available
 - GE-EPD
 - MBV
 - MAM
- Challenges in beef that don't exist in dairy
- Sequence information will add information?
- This time next year there could be a lot more



Acknowledgments



GenomeCanada





Questions?

