Canadian Bovine Genomics Workshop

September 14, 2009

Calgary, Alberta

International Beef Genomics: An Australian Example

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CRC for Beef Genetic Technologies

'Beef industry growth by Gene Discovery, Gene Expression and Accelerated Adoption' ...

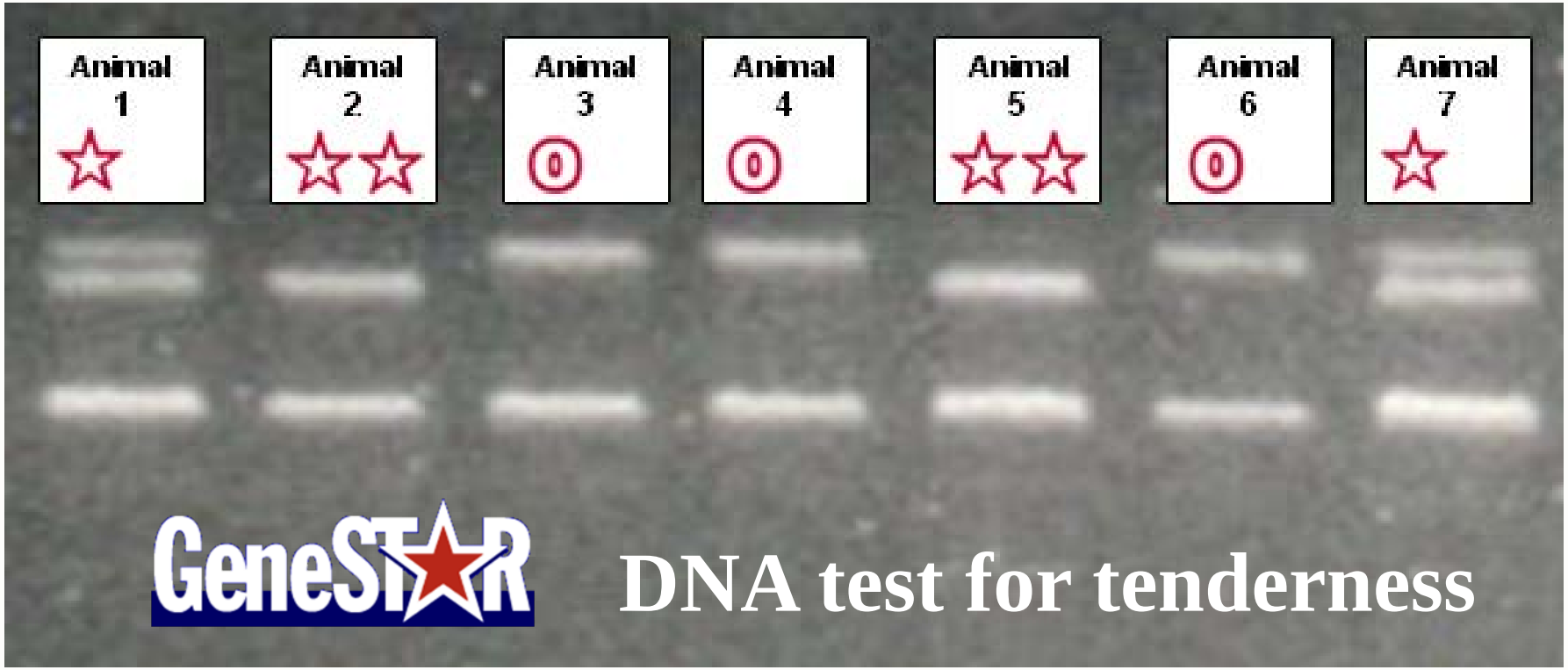
‘Gene Discovery’

to address 4 key industry priorities …

- **High Quality Beef for Global Consumers**
- **Feed Efficiency, Maternal Productivity and Responsible Resource Use**
- **Adaptation and Cattle Welfare**
- **Female Reproductive Performance**

Gene Discovery

Moving from single DNA tests …



Gene Discovery

to DNA marker panels and GWAS (SNPs associated with phenotypes for traits of interest) ***...***

to genomic selection (selection based on markers alone)

Some history …

2005: 10k Affymetrix SNP chip

2007: Simulation study results

2008: 54k Illumina SNP chip – collaboration between Canada, USA and Australia

CRC Commercialisation Rationale

- Beef CRC obliged (by conditions of funding) to maximise benefits to Australian and New Zealand beef industries
- Industry's advantage unlikely to be access to DNA markers nobody else has
- Industry's advantage likely to be through better use of DNA markers
- Cooperate with multiple research providers and commercial companies to greatest extent possible

Commercialisation

To increase adoption and industry impact …

- **Ensure industry confidence in DNA markers** *(establish criteria by which industry can value the markers; provide transparency and ready availability of results; industry education programs)*
- **Reduce costs of testing** *(create competition at genotyping level)*
- **Value-add the genotypic results** *(encourage range of service providers supporting all sectors of industry to best use genetic information i.e.* ***create new value chain for DNA markers*** *…)*

1. Integrate with BREEDPLAN (EBV^m for tenderness)

DNA Markers
- T1
- T2
- T3
- T4
- ?others

+

Phenotypic records
- Shear force
- Taste panel

+

Correlated Traits
- Flight time
- Meat colour
- ?others

+

Pedigree
- Sire
- Dam
- Progeny
- Relatives

Size of effects

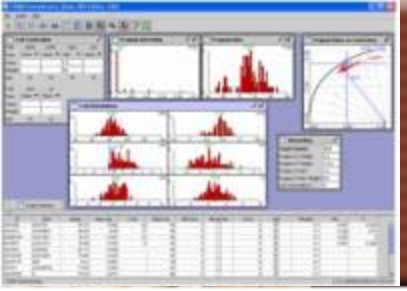
Heritabilities, variances

Size of r_gs

Relationships

MARKER ASSISTED EBV (EBV^m) FOR TENDERNESS

Method will apply to other traits in future



2. Integrate with DSS

Genetic Prediction Models

x)prime

Future technology for today

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Products

- TGRM
  - Description
  - Individual
    - What do I need?
    - Beef
    - Sheep

TGRM™ for Individual Breeding Programmes

Mate Selection for Managing Sustainable Genetic Gain

Profitable performance in the breeding industry is heavily influenced by genetic gain. Inbreeding results in loss of genetic variance, the key driver of genetic gain. Maximising



2. Integrate with DSS

Phenotypic Prediction Models

Better Meet Market Specifications = ++ $$

Improve Production Efficiency = ++ $$

Fat (& Weight) Prediction Tool 'BeefSpecs'

Feedlot Performance Tool

Decision Optimisation Tool

Maternal productivity tool

Research Models

Developed & tested with research and industry data

3. Integrate with Meat Standards Australia

MSA2009 model®

Hang (AT/TC/TS/TX)	at
HGP (Y/N)	y
Sex (M, F)	m
Est.% Bos Indicus	0
Hump Height cms	0
Hot Std Carc Weight	180
USDA Ossification	100
Milk Fed Vealer Y/N	n
USDA Marbling	380
Days Aged (min 5)	35
Quarter Point Ribfat	12
Ultimate pH	5.59
Gene Markers	??

AUSMEAT Meat Col.	3
Saleyard? (Y, N)	n

Cut Description	Reference	Days Aged	Grill	Roast Beef	Stir Fry	Thin Slice	Casserole	Corn Beef
Tenderloin	TDR062		5	5	5			
Cube Roll	CUB045		4	4	4	4		
Striploin	STR045		3	3	4	4		
Oyster Blade	OYS036		4	4	4	5		
Bolar Blade	BLD096		3	4	4	4	4	
Chuck Tender	CTR085			3	3	3	3	
Rump	RMP131		3	4	4	4		
Point End	RMP231		4	4	4	5		
Knuckle	KNU099		x	4	3	3	3	
Outside Flat	OUT005			3	3	3	3	3
Eye Round	EYE075		x	3	3	3	3	x
Topside	TOP073		x	3	3	3	3	
Chuck	CHK078			3	4	4	4	
Thin Flank	TFL051				4		4	
Rib Blade	RIB041				3			
Brisket	BRI056				3	3	3	x
Shin	FQshin						3	

International Genomics Collaborations

- Beef CRC, USDA-ARS, Universities of Alberta, Guelph and New Mexico State sharing resources & results to speed up delivery and increase industry confidence in value of DNA markers
- Beef CRC and NBCEC using same approaches to ‘validate’ or independently test markers, with full and consistent reporting via NBCEC and Beef CRC websites
- ‘Beef Information Nucleus’ being developed in Australia for ongoing testing of markers (ideally, similar concept in North America)

‘Beef Information Nucleus’

- Large-scale, industry-based breeding programs (southern & northern Australia)
- Initially driven by breed societies, but interest from other groups
- Costs leveraged by MLA Donor Company funds
- Progeny-test programs to deliver short-term genetic improvement + evaluate new markers in medium-longer term
- Phenotypes for existing BREEDPLAN traits + new research traits
- Need for coordination across BINs

NewCo Possibility?

Cattle breeders & breed societies

MLA Donor Company

$

Matching funds

BINs

Data

Fund distribution

$

Administer & coordinate BINs

Manage databases & DNA bank

Manage BIN infrastructure

Preferred Partners

Company A

Company B

Company C

Company D

Matching funds $

Annual technology access fee

NewCo

Centralized management of all databases; Not for profit company

Data

Data

Services

Most recent 2-years' data for 'validation'

Access to data >2 years old

Exclusive research on non-core traits

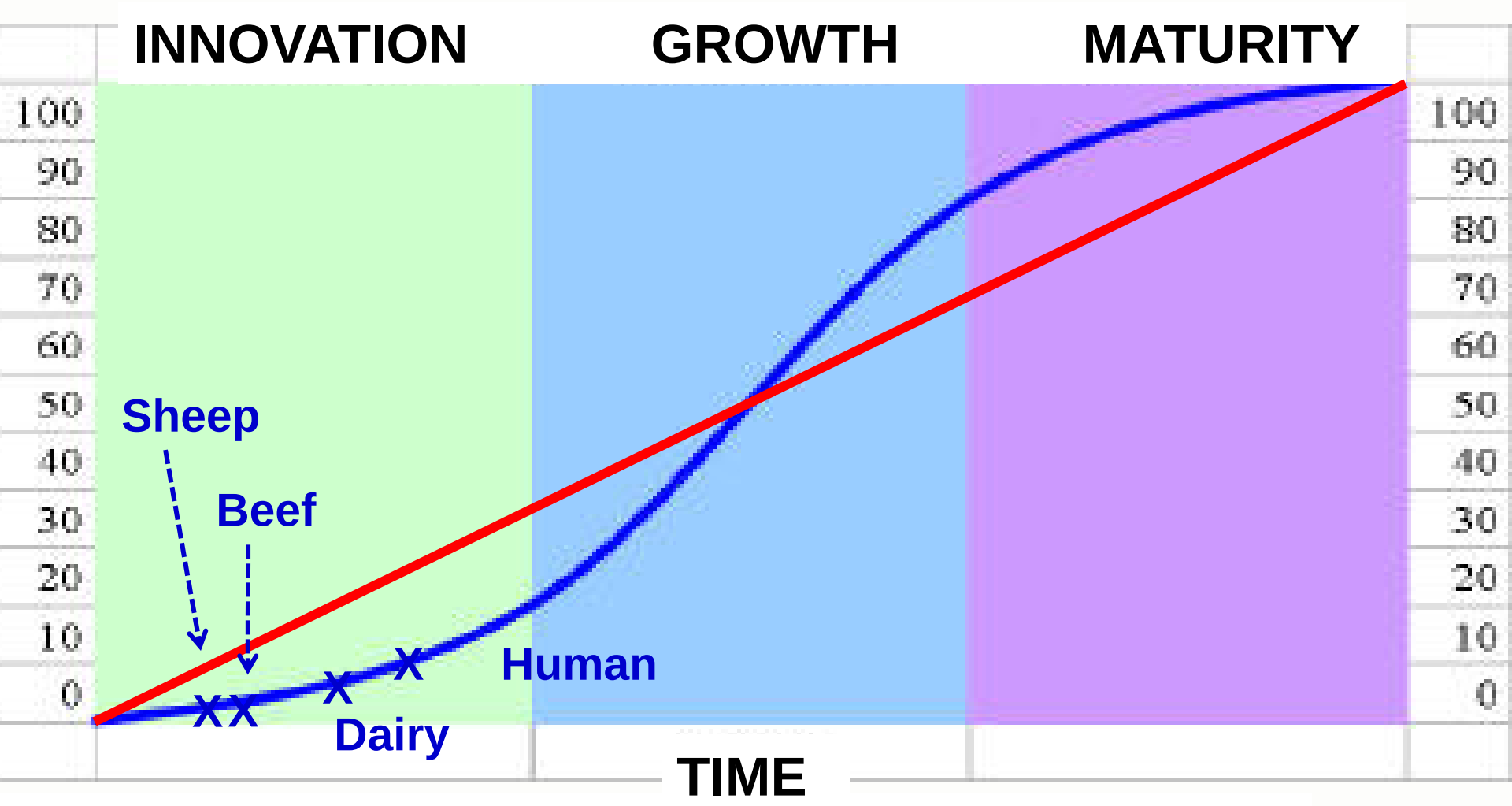
Current position

- CRC revised its targeted genetic variation from markers (by 2012) from ~50% to ‘at least 15%’
- International genomics collaboration is confirming DNA markers of value associated with steer and female traits (still small sizes of effect)
- SNP discovery efforts underway to contribute to development of larger (e.g. 300-500+k) panel to ensure markers work more effectively across breeds
- Human genomics studies suggest further research needed to account for high levels of genetic variation

Beef CRC Post-2012 Thinking

- CRC for Beef Genetic Technologies terminates June 2012
- CRC will have delivered its revised commitments (i.e. DNA markers accounting for 15+% of genetic variation will be commercially available)
- International collaborators will still have global competitive advantage in bovine genomics …
- And entire technology still at ‘bottom of S-curve’ (dairy and sheep genomics in similar situations)

Technology Performance



Industry Needs to 2030

- Improved profitability and productivity (through improved prices and throughput, reduced costs)
- Livestock based largely on pastoral production systems? (driven by increasing grain prices; biofuels; consumer reactions to ruminants being fed grain)
- ‘Environmentally-friendly’ production systems a pre-requisite (methane emissions, water usage etc)
- Livestock adapted to climate change scenarios
- Product differentiation based on consumer requirements

Livestock Genomics 'Initiative'

- Centred on beef, sheep, dairy and ?goat industries (grazing livestock)
- International collaborations (e.g. USDA, US & Canadian universities, NZ, EU, others?)
- Science at extremes of research spectrum to complement genomics companies' research
- Perhaps funded by DAFF, state departments, industry and research providers in Australia
- Possibly government-to-government funding arrangements with international partners

Possible Industry Outcomes

- 50% improvement in productivity of livestock production systems by 2030
- 50% reduction in methane per $ of livestock product by 2030
- 50% reduction in grain required per $ of livestock product by 2030
- Technology for new production systems


VH-BFA