Profiting from Information Management and Genomics

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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
A Collaborative Effort

UNIVERSITY OF ALBERTA
FACULTY OF AGRICULTURAL,
LIFE & ENVIRONMENTAL SCIENCES

Alberta Government

Agriculture and Agri-Food Canada

Agriculture et Agroalimentaire Canada

livestockgentec
delta genomics

BCRC

Alberta Innovates Bio Solutions

ALMA
Alberta Livestock and Meat Agency Ltd.
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
Genetics creates potential, management delivers
Cost Benefit of Genetic Improvement

- Value of genetic gain in the Canadian Beef Industry: $3.90 profit/ cow mated / year (selecting bulls on BW, WW, PWG)
- This is cumulative meaning in 10 years, your cows are worth $39/cow more than day 1.
- This can increase to $6.58 when including feedlot and packer traits (RFI, ADG, Carcass)
- With increases in accuracy up to $9.43 with genomics
- Who Benefits depends on when you sell and information flow
What are Your Goals

• How do you choose your cows and bulls?
• Increase my bottom line without a lot of extra time and labour
• Create Efficiencies
• Benefit the Environment
• Animal Welfare
• Low Maintenance Cattle
• World leader in cattle production
Past Success in feed efficiency (Plastow 2012)

1972
- 836 pounds
- FCR: 3.8

2007
- 715 pounds
- FCR: 2.6

32% decrease in feed conversion ratio (FCR) from 1972 to 2007.
Improving Genetic Merit

• Expected Progeny Difference (EPD)
  • Phenotype and pedigree
  • GxE=P

• Multi-trait selection indices
  • Economics and/or desired gains
  • Overcomes unfavourable correlations

INDEX

- Fertility: 58%
- Production: 23%
- Health: 9%
- Carcass: 10%
Phenotypes + Pedigree
Feed Efficiency - RFI

• Production Efficiency: 1977 vs. 2007 (Capper 2011, Animal Frontiers)

• Same amount of beef now required
  § 70% of the animals
  § 81% of the feed
  § 88% of the water
  § 67% of the land
  § Resulting in a 16% decrease in the carbon footprint of beef
Why is Feed Efficiency important?

- 56-71% of total cost of production for cow-calf operations is associated with feed, bedding and pasture (ARD 2005)

- 65-75% of the total dietary energy cost in breeding cows is required for maintenance (Ferrell & Jenkins 1985; NRC 1996)
“Prediction is very difficult, especially about the future”

Niels Bohr, Physicist
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
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)
Genomics, DNA, and Markers

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

\[ \Delta G = \frac{i \cdot r \cdot \sigma_a}{L} \]

Where;
- \( \Delta G \) is genetic gain
- \( i \) is selection intensity
- \( r \) is selection accuracy
- \( L \) is generation interval
- \( \sigma_a \) is genetic SD
How important is accuracy?

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

<table>
<thead>
<tr>
<th>Accuracy %</th>
<th>Birth Wt</th>
<th>Wean Wt</th>
<th>Milk</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>±2.4</td>
<td>±10.4</td>
<td>±8.7</td>
</tr>
<tr>
<td>30</td>
<td>±1.8</td>
<td>±8.1</td>
<td>±6.8</td>
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<tr>
<td>50</td>
<td>±1.3</td>
<td>±5.8</td>
<td>±4.9</td>
</tr>
<tr>
<td>75</td>
<td>±0.8</td>
<td>±2.9</td>
<td>±2.4</td>
</tr>
<tr>
<td>90</td>
<td>±0.3</td>
<td>±1.2</td>
<td>±1.0</td>
</tr>
</tbody>
</table>
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
Sampling

- Blood
- Tissue
- Semen
- Hair
- Nasal

- Genotype quality will be affected
- Don’t waste time and money
- Contact us for sampling kits
## Genomics’ Influence

<table>
<thead>
<tr>
<th>Trait</th>
<th>Progeny Equivalent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth Wt</td>
<td>10</td>
</tr>
<tr>
<td>Weaning Wt</td>
<td>16</td>
</tr>
<tr>
<td>Yearling Wt</td>
<td>22</td>
</tr>
<tr>
<td>Feed Efficiency</td>
<td>15</td>
</tr>
<tr>
<td>Milk</td>
<td>12</td>
</tr>
<tr>
<td>Carcass Wt</td>
<td>7</td>
</tr>
<tr>
<td>Ultrasound Backfat</td>
<td>28</td>
</tr>
</tbody>
</table>
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
Economic Questions

DNA test for replacement heifer selection?

• Assuming a 20% replacement rate for 45 calves out of a herd of 100 cows
• Remember, you need to test all of them!
• ~$13 Breakeven for a intermediate accuracy DNA test when no other data is available
• This means don’t bother until tests are less than $13 per animal

Source: Van Eenennaam NBCEC, 2012
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.
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 too 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)
## Potential uses of genomic information for beef sectors

### ONLY THESE SECTORS PRODUCE NEW ANIMALS

<table>
<thead>
<tr>
<th>Use</th>
<th>Seedstock</th>
<th>Commercial</th>
<th>Feedlot</th>
<th>Processor</th>
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</thead>
<tbody>
<tr>
<td>DNA-assisted selection</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parentage</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recessive allele testing</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control of Inbreeding</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mate selection</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DNA-assisted management</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>DNA-based purchasing</td>
<td>X</td>
<td></td>
<td>X</td>
<td>X</td>
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<tr>
<td>Product differentiation</td>
<td></td>
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<td></td>
<td>X</td>
</tr>
<tr>
<td>Traceability</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

Source: Van Eenennaam, 2012
Phenotypes...they’re important!

“In the age of the genotype, phenotype is king”
Mike Coffey, SRUC
What To Do?

1. Buy a data management software system
2. Buy Bulls with as Accurate EPD’s as possible using a selection index. (could include DNA tests) Make sure the good looking bull is also the best bull- Look at the data first
3. Balancing of traits depending on how you market animals
4. Share information up and down the value chain
5. **Sort your best and worst cows**
6. Use of Genomics (parentage, bull DNA profiles, heifer replacement tools)
7. **BE Patient**
Acknowledgments
Questions?

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