Genomic evaluations in the United States and Canada: A collaboration

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DNA sources

- Cooperative Dairy DNA Repository (CDDR)
  - Progeny-test bull semen contributed by 7 artificial-insemination (AI) organizations
  - Currently over 20,000 bulls included
- Bulls and cows nominated by AI organizations
- Cooperator contributions to research projects
- Specific semen purchases
Genotyping laboratories

- Bovine Functional Genomics Laboratory (BFGL), USDA (Beltsville, MD)
- University of Missouri (Columbia, MO)
- University of Alberta (Edmonton, AB)
- Illumina (San Diego, CA)
- Genetics & IVF Institute (Fairfax, VA)
- GeneSeek (Lincoln, NE)

SNP selection

- Minor allele frequency (MAF) > 0.05
- Portion heterozygous within 0.07 of expected
- SNP with clustering problems eliminated
- Redundant SNP eliminated
- 38,416 SNP remained
- MAF uniform 0.05 to 0.50
- Some unreadable SNP may be recovered
Accurate evaluations

- Accurate genomic evaluations require estimates of SNP effects
- Evaluations with high reliability provide the most information
- Recent animals are more useful than ones from earlier generations
- Reliability of genomic evaluations increases with number of predictor animals

Holsteins genotyped

- Graph showing the number of animals genotyped over birth years (1950-2000).
  - Bulls and Cows are differentiated by color.
Genomic evaluation & reliability

- Calculate parent average (PA) based only on genotyped animals with best linear unbiased prediction
- Combine traditional PA (or evaluation) with genomic PA and evaluation using selection index weights
- Update traditional evaluation with additional information from genomics
- Reliability from inverse of genomic relationship matrix

Data & evaluation flow

Dairy producers → DNA laboratories → Artificial-insemination organizations → Animal Improvement Programs Laboratory, USDA

- Samples and evaluations flow between entities
- Nominations and evaluations are highlighted in the diagram
Schedule

- Calculate SNP effects with each of 3 annual traditional evaluations
- Calculate genomic evaluations 1 or more times between runs
  - Recalculate SNP effects if significant number of predictor animals added
  - Use existing SNP effects if only young animals added

Official release in 2009

- Added accuracy of genomic evaluations propagated to evaluations of relatives without genotyping
- Public release of genomic evaluations
  - Cows soon after calculated
  - Bulls when enrolled with NAAB or Canadian AI organization
  - Shared by agreement with owner
Research at Guelph in 2004-2007

- Affymetrix 10,000 SNP panel
- About 6,000 SNP usable for genomic selection
- Many clusters
- Study of a wide range of genomic methods

Project at Guelph - 10,000 markers - 820 bulls

<table>
<thead>
<tr>
<th>Trait</th>
<th>PA-reliability</th>
<th>GEBV-reliability</th>
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<tr>
<td>Protein yield</td>
<td>38</td>
<td>46</td>
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<td>Fat yield</td>
<td>38</td>
<td>43</td>
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<td>SCS</td>
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<tr>
<td>Conformation</td>
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Research in Canada

- Development of GEBV for Canadian traits using data from USDA project: summer 2008
- Research collaboration with USDA:
  - Genomic methods
  - Combining genomic and phenotypic data
  - Single SNP vs haplotypes
  - Other topics

GEBV in Canada

- CDN: official GEBV planned for 2009
- Same approach as US:
  - One EBV figure using any genomic data available
  - All GEBV public when calculated
Benefits of collaboration

- Share genotypes
- Collaborate on methods
- Harmonize policy
- Exchange domestic evaluations before release date for use in SNP effect estimation

Interbull

- Can process genomic evaluations
- Genomics contribution to accuracy should be reported
  - Avoid double counting when submitted by multiple countries
  - Could be processed similar to parent contribution
- Change in 10-herd requirement needed to allow marketing bulls with only genomic information in countries without genomic evaluations
Implications

- Era of genomic prediction has begun
- Young bull acquisition and marketing as well as cow selection will use genomic data
- Routine genotyping and validation will become industry rather than research responsibilities

Financial support

- National Research Initiative grants, USDA
- Natl. Assoc. of Animal Breeders (NAAB, Columbia, MO)
  - ABS Global (DeForest, WI)
  - Accelerated Genetics (Baraboo, WI)
  - Alta (Balzac, AB)
  - Genex (Shawano, WI)
  - New Generation Genetics (Fort Atkinson, WI)
  - Select Sires (Plain City, OH)
  - Semex Alliance (Guelph, ON)
  - Taurus-Service (Mehoopany, PA)
- Agricultural Research Service, USDA