Across Breed EPD and multi-breed genetic evaluation developments

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The USDA is an equal opportunity employer.
Across breed EPD program

- Program has been in place since 1993
  - Birth, weaning, yearling weight; milk
  - Carcass traits added in 2008
  - Carcass weight added in 2015

- Develop factors that allow producers to compare genetic merit of bulls across breeds

- Data from USMARC Germplasm Evaluation Program
### 2015 ABEPD factors

**TABLE 1: ADJUSTMENT FACTORS TO ADD TO EPDs OF EIGHTEEN DIFFERENT BREEDS TO ESTIMATE ACROSS BREED EPDs**

<table>
<thead>
<tr>
<th>Breed</th>
<th>Birth Wt. (lb)</th>
<th>Weaning Wt. (lb)</th>
<th>Yearling Wt. (lb)</th>
<th>Maternal Milk (lb)</th>
<th>Marbling Score&lt;sup&gt;3&lt;/sup&gt;</th>
<th>Ribeye Area (in&lt;sup&gt;2&lt;/sup&gt;)</th>
<th>Fat Thickness (in)</th>
<th>Carcass Wt. (lb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angus</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.00</td>
<td>0.00</td>
<td>0.000</td>
<td>0.0</td>
</tr>
<tr>
<td>Hereford</td>
<td>2.7</td>
<td>-4.4</td>
<td>-26.6</td>
<td>-17.8</td>
<td>-0.32</td>
<td>-0.10</td>
<td>-0.053</td>
<td>-6.2</td>
</tr>
<tr>
<td>Red Angus</td>
<td>3.4</td>
<td>-25.7</td>
<td>-30.9</td>
<td>2.4</td>
<td>-0.32</td>
<td>0.03</td>
<td>-0.023</td>
<td>-11.6</td>
</tr>
<tr>
<td>Shorthorn</td>
<td>5.1</td>
<td>-30.7</td>
<td>-12.3</td>
<td>4.6</td>
<td>-0.24</td>
<td>0.31</td>
<td>-0.107</td>
<td>-11.6</td>
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<tr>
<td>South Devon</td>
<td>3.6</td>
<td>-8.0</td>
<td>-25.9</td>
<td>2.4</td>
<td>-0.09</td>
<td>0.21</td>
<td>-0.129</td>
<td>-22.3</td>
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<td>Beefmaster</td>
<td>5.7</td>
<td>36.1</td>
<td>32.3</td>
<td>11.9</td>
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<tr>
<td>Brahman</td>
<td>10.9</td>
<td>47.5</td>
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<td>-0.11</td>
<td>-0.146</td>
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<tr>
<td>Brangus</td>
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<td>5.1</td>
<td>4.6</td>
<td></td>
<td></td>
<td></td>
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<td>Santa Gertrudis</td>
<td>6.9</td>
<td>41.4</td>
<td>42.2</td>
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<td>Braunvieh</td>
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<td>Charolais</td>
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<td>40.8</td>
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<td>0.98</td>
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<td>Chiangus</td>
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<td>0.34</td>
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<td>Gelbvieh</td>
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<td>0.98</td>
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<td>Maine-Anjou</td>
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<td>-35.0</td>
<td>-3.6</td>
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<td>Salers</td>
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<td>-26.3</td>
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<tr>
<td>Tarentaise</td>
<td>3.1</td>
<td>28.3</td>
<td>9.6</td>
<td>23.4</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

<sup>3</sup>Marbling score units: 4.00 = SI<sup>00</sup>; 5.00 = Sm<sup>00</sup>.
Genetic Trends for Yearling Weight, lb

Adapted from Spring 2015 Genetic Trends from Breed Associations and 2015 AB-EPD factors
Limitations of ABEPD program

• Factors do not account for difference in heterosis in commercial cross
  – Angus vs. Simmental bull with Angus females

• Additive factors not adequate to accommodate many traits
  – Calving ease, heifer pregnancy, etc.

• Yearly updates not sufficient for continuously updated national cattle evaluations
Possible solutions

• Web-based decision support
  – Current focus of a collaboration/grant
    • KSU, UNL, CSU, USMARC, Bruce Golden
  – Could combine with bioeconomic simulation
  – Heterosis, trait scaling, continuous updates all possible

• Multibreed evaluation
  – Current implementation by American Simmental Association/International Genetic Solutions (ASA/IGS)
Obstacles to full Multibreed

• Merger of multiple breed databases
  – Structures are often very different
  – IDs duplicated in several breeds (but not known as duplicates)
    • Difficult to resolve
    • Standardized ID system would help

• Cooperation between database curators
  – Breed associations
  – Genetic prediction ‘centers’
  – Individual producers/commercial entities
Multibreed obstacles

• Estimating population parameters
  – Direct and maternal heterosis
  – Direct and maternal additive breed effects
  – Field data usually not suitable
    • Contemporary groups structure
      – Will discuss further
    • Confounding between heterosis and breed
    • Amount of crossbred data relative to purebred
      (depends on classification of ‘purebred’)

• Research data useful here
Contemporary groups

- In order to estimate breed differences from field data, we need contemporary groups that include purebreds of both breeds
  - Rarely occurs; often breeds are in different groups
  - Even when crossbreds and purebreds are in the same group, direct comparisons are not possible without adjusting for heterosis (requires good estimates of heterosis)
Estimation of heterosis

• In order to estimate heterosis from field data, we need groups with crossbreds and purebreds of both parental breeds
  – Rarely occurs; usually crossbreds are in a different groups
  – Even when crossbreds and purebreds are in the same group, typically purebreds of only one of the breeds are present
Estimating breed differences

• Contemporary group

<table>
<thead>
<tr>
<th>Sire 1: Limousin</th>
<th>Sire 2: Angus</th>
<th>Sire 3: Lim-Flex</th>
</tr>
</thead>
<tbody>
<tr>
<td>WW Avg: 650 lb</td>
<td>WW Avg: 675 lb</td>
<td>WW Avg: 670 lb</td>
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</table>

– All mated to mature purebred Limousin cows
– What was the cause of the different averages?
  • Heterosis
  • Sire breeding value
  • Breed differences

YES (and no)
Estimating breed differences

- Problem can be improved with more sires in group still other considerations that are difficult to address
  - Reciprocal matings
  - Biased sampling of sires from other breeds
  - Heterosis still difficult to separate from breed
  - Were calves really treated the same?
Multibreed model

- Prior estimates of breed effects and heterosis essentially required

- Source of information most likely from research data
  - GPE program is designed to estimate breed differences from current industry samples
Proposal

• Use breed differences from GPE to parameterize multibreed model currently in use by American Simmental Association
  – Provide both breed effects and heterosis
  – Can basically pre-adjust data for breed composition
  – Need to consider where the programs are different and how to accommodate differences
GPE Target Population Structure

AI Sires:
AN, HH, SM, CH, AR, LM, GV, SH, BN, BM, MA, BR, CI, SG, SA, BV, SD, TA

PB & F₁ Steers

PB & F₁ Bulls

PB & F₁ Heifers

Natural Service PB, F₁, & F₂ Steers & Heifers
Across breed differences

<table>
<thead>
<tr>
<th>Breed</th>
<th>Birth Wt. (lb)</th>
<th>Weaning Wt. (lb)</th>
<th>Yearling Wt. (lb)</th>
<th>Maternal Milk (lb)</th>
<th>Marbling Score&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Ribeye Area (in&lt;sup&gt;2&lt;/sup&gt;)</th>
<th>Fat Thickness (in)</th>
<th>Carcass Wt. (lb)</th>
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<tbody>
<tr>
<td>Angus</td>
<td>86.6</td>
<td>570.2</td>
<td>1041.9</td>
<td>558.2</td>
<td>6.14</td>
<td>13.24</td>
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<td>904.9</td>
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<td>Hereford</td>
<td>90.9</td>
<td>562.8</td>
<td>1004.2</td>
<td>536.4</td>
<td>5.36</td>
<td>12.93</td>
<td>0.606</td>
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<td>1009.9</td>
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<tr>
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<td>537.5</td>
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<td>559.5</td>
<td>5.41</td>
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<tr>
<td>South Devon</td>
<td>91.0</td>
<td>555.4</td>
<td>1008.7</td>
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<td>Brahman</td>
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<td>883.9</td>
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<td>Santa Gertrudis</td>
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<td>1001.2</td>
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<td>4.97</td>
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<tr>
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<tr>
<td>Charolais</td>
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<td>1042.2</td>
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<td>536.6</td>
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<td>13.26</td>
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<tr>
<td>Gelbvieh</td>
<td>88.6</td>
<td>566.2</td>
<td>1020.9</td>
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<td>Limousin</td>
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<td>567.5</td>
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<tr>
<td>Maine-Anjou</td>
<td>91.2</td>
<td>541.0</td>
<td>978.6</td>
<td>548.7</td>
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</table>

<sup>a</sup>Marbling score units: 4.00 = SI<sup>00</sup>; 5.00 = Sm<sup>00</sup>
Potential problems

• Currently, priors for ASA/IGS model are for breed by year effects
  – GPE analysis based on sampling from industry sires and adjusting solutions to the EPDs of the sampled bulls
    • In essence using breed genetic trends to adjust solutions from GPE data
    • Only Hereford and Angus bulls sampled throughout GPE
    • Interpolation likely necessary
Potential problems

• New trait development
  – Currently summarize whole GPE database for weight traits and carcass traits as part of the ABEPD process

  – Still missing CED, CEM, stayability and heifer pregnancy that are reported for several breeds

    • Multinominal distributions of these traits will require some form of scaling from GPE to multibreed
Potential problems

• Heterosis
  – While heterosis is reported as part of GPE, prior to current continuous sampling protocol, most estimates were based on Angus x Hereford crosses
  – One goal of current program is to estimate breed-specific heterosis
    • Important for multibreed
    • Still far from complete
Possible solutions

• Breed x year solutions
  – Need to examine what we can do to fill in the years
  – Current ASA method places a high correlation among yearly estimates
  – Possibly can reference old solutions and newer solutions and interpolate
    • Adjust within years by within group EPD differences
    • Would exclude genetic trend (circular logic)
Possible solutions

• New trait development
  – Have already prototyped CED with UNL collaboration
    • For ABEPD system, need to put all breeds on the same scale then transform to breed of interest
    • Scaled EPD by additive SD of EPD
    • Similar methodology could be applied to heifer pregnancy and stayability
      – Records may be limited on some breeds in GPE, but will grow over time
Possible solutions

• Breed specific heterosis
  – UNL collaboration also developed to begin exploring breed and breed-type specific heterosis (Schiermiester et al., 2015)
  • Fitting main effect of heterosis (or breed-type) and random breed specific heterosis effects
  • Resolution not great yet, but evidence of breed-type specific heterosis for weight traits
  • Working on increasing crosses between 7 largest breeds and of those breeds with all others
Future plans

• Continue trait development and examination of breed effect model implications
  – Important training in NCE for graduate student development
Conclusion

• We think the GPE program and the multibreed model are a natural fit

• Will improve the base adjustment among current members of IGS

• Can help to transition to mating and selection decision support programs
Acknowledgements

Bruce Golden
Wade Shafer
Warren Snelling
Mark Thallman
Matt Spangler
Lauren Hyde
Discussion and questions?

- Mention of a trade name, proprietary product, or specific equipment does not constitute a guarantee or warranty by the USDA and does not imply approval to the exclusion of other products that may be suitable.