Carcass Video Images in Genetic Evaluation and Breeding Program in Ireland

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Beef production in Ireland

2 million cows
- 1,000,000 beef cows
- 14 cows / herd
- 6 major beef breeds
  - CH LM AA SI HE BB
- Large uses of cross breeding

Destination
- 16% Live export
- 69% Slaughtered in Ireland
- 15% replacement
Beef breeding objective

**SUCKLER BEEF VALUE**
(€/calf)
Current assessment of carcass quality

- The EUROP carcass classification
  - Assessment of conformation & fat grades by experts/machines

S > E > U > R > O > P
15 > > > > > > > > 1

1 < 2 < 3 < 4 < 5
1 > > > > > > > > 15

=> Current selection tool for carcass quality
Motivations

- Improving carcass quality

Going deeper in the carcass => new selection tools for carcass quality?
Objective

- Is it possible to create new carcass traits from digital images?

- Is that interesting/useful for farmers and the industry?
Data used: Primal cuts

- Research center: n = 413 (mostly) steers
- Commercial partner: n = 615 (mostly) heifers
Heritability of primal cuts

- Calculated on 346 steers


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Why creating new traits?

Primal cuts

• Interest for farmers / industry... **Yes!**

• Genetic variability......................... **Yes!**

• Availability.................................. **No**
Mechanical grading of carcasses

- EUROP grades
  - Conformation
  - Fat

Carcass digital images routinely stored since July 2005 (~15 million images)

Predict carcass cuts from images?
Data used: Wholesale cuts

- Primal cuts grouped by retail value (steers & heifers)

14 primal cuts

4 wholesale cuts

- Lower value cuts
- Medium value cuts
- High value cuts
- Very high value cuts
Predicting weights from images

- Building prediction equations
  - Using multivariate analysis
  - Calibration (2/3 data) / validation (1/3 data)
  - Built on 346 steers & 281 heifers

428 variables
(contour, length, volume, surface...)

# Accuracy of prediction

## R² of prediction in validation datasets

<table>
<thead>
<tr>
<th></th>
<th>STEER</th>
<th>HEIFER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total meat</td>
<td>0.97</td>
<td>0.84</td>
</tr>
<tr>
<td>Total fat</td>
<td>0.77</td>
<td>n/a</td>
</tr>
<tr>
<td>Total bone</td>
<td>0.81</td>
<td>n/a</td>
</tr>
<tr>
<td>Lower Value Cuts</td>
<td>0.92</td>
<td>0.65</td>
</tr>
<tr>
<td>Medium Value Cuts</td>
<td>0.86</td>
<td>0.70</td>
</tr>
<tr>
<td>High Value Cuts</td>
<td>0.93</td>
<td>0.85</td>
</tr>
<tr>
<td>Very High Value Cuts</td>
<td>0.84</td>
<td>0.72</td>
</tr>
</tbody>
</table>
Generating new phenotypes

- Obtained by applying prediction equations to the digital images historically stored
- Across 14 slaughter houses

Access to large supply of carcass cuts
# Genetics of predicted weights

- Heritability on diagonal
- Genetic correlations off diagonal: HEIFERS & STEERS

<table>
<thead>
<tr>
<th></th>
<th>Total meat</th>
<th>Total fat</th>
<th>Total bone</th>
<th>LVC</th>
<th>MVC</th>
<th>HVC</th>
<th>VHVC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total meat</td>
<td>0.44</td>
<td>-0.61</td>
<td>-0.24</td>
<td>0.71</td>
<td>0.78</td>
<td>0.93</td>
<td>0.80</td>
</tr>
<tr>
<td>Total fat</td>
<td>n/a</td>
<td>0.14</td>
<td>0.13</td>
<td>-0.50</td>
<td>-0.56</td>
<td>-0.58</td>
<td>-0.54</td>
</tr>
<tr>
<td>Total bone</td>
<td>n/a</td>
<td>n/a</td>
<td>0.49</td>
<td>-0.22</td>
<td>-0.23</td>
<td>-0.35</td>
<td>-0.62</td>
</tr>
<tr>
<td>LVC</td>
<td>0.87</td>
<td>n/a</td>
<td>n/a</td>
<td>0.18</td>
<td>0.45</td>
<td>0.66</td>
<td>0.57</td>
</tr>
<tr>
<td>MVC</td>
<td>0.75</td>
<td>n/a</td>
<td>n/a</td>
<td>0.47</td>
<td>0.27</td>
<td>0.79</td>
<td>0.86</td>
</tr>
<tr>
<td>HVC</td>
<td>0.89</td>
<td>n/a</td>
<td>n/a</td>
<td>0.80</td>
<td>0.82</td>
<td>0.40</td>
<td>0.89</td>
</tr>
<tr>
<td>VHVC</td>
<td>0.82</td>
<td>n/a</td>
<td>n/a</td>
<td>0.69</td>
<td>0.82</td>
<td>0.82</td>
<td>0.17</td>
</tr>
</tbody>
</table>

*Pabiou et al. (2011a) Animals*
Relationship with pre-slaughter traits

Farmer scores for calf quality
0.12 \leq r_g \leq 0.49

Auction prices
0.34 \leq r_g \leq 0.67

Work that useful in animal breeding?
0.35 \leq r_g \leq 0.69

Post-Weaning age
Muscle: 0.10 \leq r_g \leq 0.53
Skeletal: -0.18 \leq r_g \leq 0.11

Weaning age
Muscle: -0.47 \leq r_g \leq 0.63
Skeletal: -0.58 \leq r_g \leq 0.09

Live weights
Post-Weaning age
Direct: -0.07 \leq r_g \leq 0.14

Weaning age
Direct: -0.34 \leq r_g \leq 0.01
Maternal: -0.16 \leq r_g \leq 0.07

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Are we there yet?

Predicted wholesale cuts

- Interest for farmers / industry… **Yes!**
- Availability………………………………**Yes!**
- Genetic variability………………………**Yes!**
- Correlations with other traits…. **Yes!**
- Potential benefit for industry  **?”

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Objective & Indexes

Breeding goal = **Suckler Beef Value**

- **Index 1**
  - Live traits
- **Index 2**
  - Live traits
  - Carcass weight
- **Index 3**
  - Live traits
  - Carcass weight
  - EUROP grades
  - *Built with predicted cut*
- **Index 4**
  - Live traits
  - Carcass weight
  - EUROP grades
  - Predicted cuts
- **Index 5**
  - More accurate predictions

Selection indexes
# Benefits of adding predicted cuts to the carcass index

<table>
<thead>
<tr>
<th>Scenari tested</th>
<th>Using carcass weight</th>
<th>Using EUROP grades</th>
<th>Using predicted carcass cuts</th>
<th>Using more accurate prediction of carcass cuts</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Comparison of with</strong></td>
<td><strong>Scenario 1</strong></td>
<td><strong>Scenario 2</strong></td>
<td><strong>Scenario 3</strong></td>
<td><strong>Scenario 4</strong></td>
</tr>
<tr>
<td>10 years</td>
<td>+ € 7.3</td>
<td>+ € 0.6</td>
<td>+ € 2.4</td>
<td>+ € 0.6</td>
</tr>
</tbody>
</table>
Conclusions

- Using phenotypes predicted from VIA for selection purpose is feasible
  - Accurate regressions equations for steers and heifers
  - Routinely available supply of predicted carcass weights
- and beneficial for the Irish industry
  - Exploitable genetic variations
  - Strong genetic associations with early predictors
    - Auction price at weaning and post-weaning
  - New selection index including predicted cuts:
    - increased responses on Carcass sub-index and Suckler Beef Value
  - Potentially the next Quality Payment System?
In other words

- Is it possible to create new carcass traits from digital images?
  - YES

- Is that interesting/useful for farmers and the industry?
  - YES
Future research

- Strengthen current prediction equations
  - Heifers
  - Bulls & cows
- Investigate meat quality & other technologies
  - Tenderness
- Beef genomic selection will include in time carcass cuts traits
  - In progress
- Expand knowledge to sheep
  - Build on UK research
- Explore ways of collecting more phenotypes
  - Collective organisation
In other words

• This is only a beginning

Thank you.