CT & Automatic Imaging Systems for a Value-Based Marketing System in Pig

Gérard Daumas
Co-authors

- Tamas Donko, Kaposvar University, Hungary
- Maria Font-i-Furnols & Marina Gispert, IRTA Monells, Spain
- Mathieu Monziols, IFIP Le Rheu, France
- Eli Olsen, DMRI Roskilde, Denmark
**Introduction: FAIM framework**

- FAIM session
- WG1: Body/Carcass Composition
- To review and develop robust references
- To agree on strategies for defining references
- To review and develop harmonised procedures for *iv, pm* and on-line imaging methods of predicting compositional traits
FAIM session: IMAGING
Pig Grading: EU regulation under discussion
WG1: Carcass Composition
To review and develop robust references: CT
To review and develop harmonised procedures for \( pm \) and on-line imaging methods of predicting compositional traits: LMP (Lean Meat %)
3 compulsory constraints

- LMP is assessed by means of authorised grading methods
- Only statistically proven assessment methods may be authorised
- Authorisation is subject to compliance with a maximum tolerance for statistical error
EU requirements for calibrating pig classification instruments

- Reference = dissected LMP
- Prediction by using objective anatomical traits
- Representative sample
- N > 120 or n1 > 50 if Double Regression
- A proven statistical procedure
- RMSEP < 2.5
LMP definitions

- 2006: dissected LMP in the 4 main joints
- + 2008: dissected LMP in the carcass
- + 2008: “The dissection may also be replaced by assessing the LMP by means of total dissection with a CT on the condition that satisfactory comparative dissection results are provided”.
  (EC Regulation No 1249/2008)
- Consensus between national experts
Reference = Manual Dissection / Knife

- CT has to be calibrated against dissection
- DE, DK, ES, HU

Reference = Virtual Dissection / CT

- No manual dissection
- FR
DE, ES & HU procedures

- Scan of the left side (« total dissection with CT »)
- Knife Dissection:
  - DE: the whole side
  - ES & HU: the 4 main joints
- PLS on the HU spectra
  - DE: +10 / + 95
  - ES: - 100 / + 120
  - HU: -100 / + 100
- RMSEP
  - DE: 0.7 (Judas et al, 2007)
  - ES: 0.8 (Font i Furnols et al, 2009)
  - HU: 1.4 (Donko & Komlosi, 2011)
Scan of the carcass (« total dissection with CT »)
Knife Dissection: the 4 main joints
Carcass weight model
Densities estimated on a subsample (n=29) with carcass dissection
Contextual classification into 3 tissues: meat, fat & bone
RMSEP = 0.5 (Vester-Christensen et al, 2009)
\[ W = V_{\text{fat}} \cdot \beta_{\text{fat}} + V_{\text{meat}} \cdot \beta_{\text{meat}} + V_{\text{bone}} \cdot \beta_{\text{bone}} \]

- \( W \): Estimated weight of ½ carcass
- \( V \): Volume (estimated from images)
- \( \beta \): Estimated average density

\[ \text{LMP} = \frac{V_{\text{meat}} \cdot \beta_{\text{meat}}}{W} \times 100\% \]
Concept

CT scanners are physical instruments designed for measuring volumes and densities

LMP = 100 x Muscle Weight / Entity Weight

Muscle Weight = Muscle Volume x Muscle Density

Implementation

Muscle Density = Constant = 1.04 (ICRU, 1989)

Muscle Volume = Thresholds 0 – 120

Daumas & Monziols, 2011, ICoMST
Adaptation of the FR strategy

- Scan of the 4 main joints
- Dissection of the 4 main joints
- Same entity
- RMSEP = 0.5 by thresholding
- RMSEP = 0.3 + math. Morphology (rind)
### Industrial implementation (pig grading)

<table>
<thead>
<tr>
<th>RMSEP</th>
<th>Country</th>
<th>Year</th>
<th>LMPdis</th>
<th>CT scan</th>
<th>Method</th>
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### Research

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</table>
3 automatic imaging systems

- **AutoFom:**
  - Ultra-sounds on non eviscerated pig
  - DK company Carometec
  - 2 versions: I & III

- **Image-Meater**
  - 1 camera for the splitline
  - DE company CSB

- **VCS 2000**
  - 3 cameras for the splitline
  - DE company E+V
AutoFom™

National Approvals

Country, year of approval and the number of slaughterhouses using AutoFom I / AutoFom III:

- Belgium (2012), 2 slaughterhouses slaughtering 2 million pigs annually
- Denmark (2012), 9 slaughterhouses slaughtering 18 million pigs annually
- Finland (2008), 2 slaughterhouses slaughtering 3 million pigs annually
- France (2007), 2 slaughterhouses slaughtering 2.5 million pigs annually
- Germany (2011), 28 slaughterhouses slaughtering 43 million pigs annually
- Poland (2011), 3 slaughterhouses slaughtering 3.1 million pigs annually
- Spain (2012), 16 slaughterhouses slaughtering 22 million pigs annually
- Sweden (1997), 2 slaughterhouses slaughtering 1.5 million pigs annually
- Switzerland (1998), 6 slaughterhouses slaughtering 3 million pigs annually
- UK (2004), 2 slaughterhouses slaughtering 1.5 million pigs annually
- USA (1995), 2 slaughterhouse slaughtering 5 million pigs annually

Total number of carcasses measured by AutoFom™: 105 million per year in 74 slaughter sites in 11 countries
### Accuracy of Autofom

#### AUTOFOM I

<table>
<thead>
<tr>
<th>RMSEP</th>
<th>Country</th>
<th>Year</th>
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#### AUTOFOM III

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<tr>
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1.6 < RMSEP < 2.2

1.1 < RMSEP < 1.8
The calibrations are probably more different than the pig populations.

Four approved Autofom formulas used at the same samples

<table>
<thead>
<tr>
<th>Formula</th>
<th>Sample 1</th>
<th>Sample 2</th>
<th>Sample 3</th>
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<td>57</td>
<td>56</td>
<td>57</td>
<td>56</td>
</tr>
</tbody>
</table>
The 16 variables of Image-Meater
8 fat + 6 muscle depths + 2 lengths
### Accuracy of VIA

**Image-Meater**

<table>
<thead>
<tr>
<th>RMSEP</th>
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<tr>
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**VCS 2000**

<table>
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<tr>
<td>2.2</td>
<td>V</td>
<td>2008</td>
<td>4 joints</td>
</tr>
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</table>

2.0 < RMSEP < 2.5  
2.0 < RMSEP < 2.2
Comparison of error/accuracy

**Prediction Error**
- Autofom III  \(1.1 < \text{RMSEP} < 1.8\) (1.7)
- Autofom I  \(1.6 < \text{RMSEP} < 2.2\)
- VCS 2000  \(2.0 < \text{RMSEP} < 2.2\)
- Image-Meater  \(2.0 < \text{RMSEP} < 2.5\) (2.4)

**Accuracy**
- AFOM III > AFOM I > VCS > Image-Meater
- Greater variability with Autofom
- Trial effect: national population, year, reference, predictors, sampling, statistical analysis, …
Million of pigs classified and paid by automatic imaging systems in the main countries:

- DK: Autofom = 13 Mio
- DE: Autofom = 30 Mio
- FR: Image-Meater = 18 Mio
France: Weight payment

% of pigs

Premium or Penalty
Cent € / kg
France: LMP payment

Premium or Penalty
Cent € / kg

% of pigs

LMP
<table>
<thead>
<tr>
<th>LMP</th>
<th>Cumulative dif.</th>
<th>Dif. / point</th>
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<tbody>
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<td>51</td>
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<tr>
<td>≤50</td>
<td>-40</td>
<td>-20</td>
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</table>
Payment example

- Basis Price (56 LMP & 80-102 kg) = 1.50 €/kg
- Example: 91 kg & 61 LMP
- Weight premium = + 0.02 €/kg
- LMP premium = + 0.17 €/kg
- Total bonus = 0.02 €/kg + 0.17 €/kg = 0.19 €/kg
- Price per kg = 1.50 €/kg + 0.19 €/kg = 1.69 €/kg

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- Hot weight = 91.0 kg
- Rebate (hot/cold & various) = 3 %
- Cold weight = 91.0 x (1 - 0.03) = 88.3 kg

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PIG VALUE = 88.3 kg x 1.69 €/kg = 149.23 €
Denmark: LMP

- **Base = 61 %**
- **62 – 65 % = + 10 øre = + 1,3 ct € /%/kg**
- **57 - 60 % = - 10 øre = - 1,3 ct € /%/kg**
- **50 - 56 % = - 20 øre = - 2,7 ct € /%/kg**
Conclusion

- CT nationally used as a 2ry reference:
  - Additional dissection costs
  - Additional errors
  - Biases between MS
- Automation & Imaging are increasing
- Accuracy:
  - AFOM III > AFOM I > VCS > Image-Meater
But other criteria are more important for the choice
- 2 payment systems: LMP or Quality Joints Index
Merci de votre attention

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Thanks to Inaporc for the financial support

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