Beef Eating Quality
- a European Journey

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Beef Eating Quality - a European Journey

- Challenges for the European beef industry
- Beef quality assurance
- Recent research
- Way forward?
Diversity

“European beef industry”

• Diversity of:
  - Breeds
  - Rearing regimes
  - Processing
  - Consumer preferences
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Challenges

- Environmental impact
- Carbon footprint
- Animal Welfare
- Authenticity
- Nutrition & health
- Price
- Quality

Value for money?
European consumer studies on beef:

- 774 carcases, 18 muscles, 15,000 consumers, 5 countries:
  - 20% grilled striploin
  - 25% grilled rump
  - 54% roast topside

= “Unsatisfactory”

Bonny, S. et al. 2015; Farmer et al., 2016
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Value for Money?

Beef is expensive and inconsistent

- Consequences?
  - Declining beef consumption?
  - Demand for reliable products
    - fillet and mince?
- Not unique to European beef!
- Not a new problem

What has been done?

What can be done?

European Environment Agency: www.eea.europa.eu
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Industry Priorities

How can Europe get the best value out of its beef?

What needs to be done to ensure sustainability of the European beef industry over the next 10 years?

SUSTAINABLE BEEF QUALITY FOR EUROPE
A Workshop for Industry & Scientists
Milan, October 2015

Farmer et al., Viandes et Produits Carnes, 2016
Eating Quality
- Reduce inconsistency
- Methods to monitor eating quality
- Identify cost of unacceptable quality

Nutritional quality
- Better knowledge of nutritional benefits

Consumers
- Greater communication with consumers (esp. nutrition)
- Greater understanding of consumers
- Halt the decline in consumption

Production
- Greater efficiency at farm level

Farmer et al., Viandes et Produits Carnes, 2016
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**Beef quality assurance**

- **Beef classification schemes**
  - To describe beef to distant buyers and sellers:
    - carcase weight, age/maturity, sex, fat cover/colour, conformation, freedom from bruising ...

- **Beef grading**
  - To place different values on carcases for pricing purposes
    - USDA, EUROP & fat class

- **Farm quality assurance schemes**
  - To QA production systems, animal welfare, traceability ...
    - Red tractor, Label Rouge, Farm Quality Assured (NI) ...

- **Eating quality grading**
  - To quality assure eating quality ...
    - UK Blueprint, USDA, MSA ...

*AHDB, 2008; Polkinghorne & Thompson 2010*
# Beef eating quality systems

## Summary of classifications

<table>
<thead>
<tr>
<th>Grades</th>
<th>MLC</th>
<th>USDA</th>
<th>NZ QMark</th>
<th>MSA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outside system</td>
<td>Ungraded</td>
<td>Ungraded</td>
<td>Ungraded</td>
<td>Ungraded / failed</td>
</tr>
<tr>
<td>Graded as unsatisfactory</td>
<td></td>
<td>Utility</td>
<td></td>
<td>Unsatisfactory</td>
</tr>
<tr>
<td>Graded as satisfactory or good</td>
<td>Blueprint</td>
<td>Standard (x3)</td>
<td>QMark</td>
<td>3*</td>
</tr>
<tr>
<td></td>
<td>“Blueprint plus”</td>
<td>Select (x2)</td>
<td></td>
<td>4*</td>
</tr>
<tr>
<td></td>
<td>(~21d ageing)</td>
<td>Choice (x3)</td>
<td></td>
<td>5*</td>
</tr>
<tr>
<td></td>
<td>Prime (x3)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grade applied to:</td>
<td>whole carcase</td>
<td>whole carcase</td>
<td>whole carcase</td>
<td>each cut / ageing period / cooking method</td>
</tr>
<tr>
<td></td>
<td>(selected</td>
<td>(cuts not</td>
<td>(selected</td>
<td></td>
</tr>
<tr>
<td></td>
<td>premium cuts)</td>
<td>specified)</td>
<td>premium cuts)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Beef eating quality systems

#### Main factors

<table>
<thead>
<tr>
<th>MLC</th>
<th>USDA</th>
<th>NZ QMark</th>
<th>MSA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>Maturity (oss.)</td>
<td>Age (teeth)</td>
<td>Breed (Brahman)</td>
</tr>
<tr>
<td>Maturity (teeth)</td>
<td>Marbling</td>
<td>Marbling</td>
<td>Maturity (oss.)</td>
</tr>
<tr>
<td>Fat cover</td>
<td>Visible meat texture &amp; colour</td>
<td>Transport/mixing/lairage</td>
<td>Fat cover</td>
</tr>
<tr>
<td>Fat class</td>
<td>pH/temp. decline</td>
<td>pH/temp. decline</td>
<td>Marbling</td>
</tr>
<tr>
<td>Hanging method</td>
<td>Electrical stimulation</td>
<td>pHU</td>
<td>Transport/mixing/lairage</td>
</tr>
<tr>
<td>Chill regime</td>
<td>Shear force</td>
<td>pHU</td>
<td>pH/temp. decline</td>
</tr>
<tr>
<td>Meat and fat colour</td>
<td></td>
<td>Shear force</td>
<td>Meat &amp; fat colour</td>
</tr>
<tr>
<td>pHU</td>
<td></td>
<td></td>
<td>pHU</td>
</tr>
<tr>
<td>EUROP Grade</td>
<td></td>
<td></td>
<td>Hanging method</td>
</tr>
<tr>
<td>Ageing (Bulls)</td>
<td></td>
<td></td>
<td>Electrical stimulation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Ageing</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Cut/muscle</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Cooking method</td>
</tr>
</tbody>
</table>

*Statistical evaluation of how well these factors predict consumer satisfaction*
How well do systems differentiate consumer satisfaction?

<table>
<thead>
<tr>
<th></th>
<th>MLC</th>
<th>MLC omitting conform’n</th>
<th>US-Grade</th>
<th>NZ-QMark</th>
<th>MSA-AU</th>
<th>MSA +Bulls</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Grilled steak</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Striploin – anterior (STR045-A)</td>
<td>✓</td>
<td>✓</td>
<td>X</td>
<td>X</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Striploin – mid (STR045-M)</td>
<td>X</td>
<td>X</td>
<td>✓✓</td>
<td>✓</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Striploin – posterior (STR045-P)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Rump cap (RMP005)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Rump heart (RMP131)</td>
<td>✓</td>
<td>✓✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓✓</td>
</tr>
<tr>
<td>Rump (RMP231)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>X</td>
<td>✓</td>
<td>✓✓</td>
</tr>
<tr>
<td><strong>Total (grilled)</strong></td>
<td>4</td>
<td>5</td>
<td>5</td>
<td>4</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td><strong>Roast beef</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Silverside eye (EYE075)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>✓</td>
</tr>
<tr>
<td>Silverside (OUT005)</td>
<td>✓</td>
<td>✓</td>
<td>X</td>
<td>✓</td>
<td>✓</td>
<td>✓✓</td>
</tr>
<tr>
<td>Rump heart (RMP131)</td>
<td>X</td>
<td>X</td>
<td>XX</td>
<td>X</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Rump (RMP231)</td>
<td>✓</td>
<td>✓✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓✓</td>
</tr>
<tr>
<td>Topside (TOP073)</td>
<td>✓</td>
<td>✓✓</td>
<td>X</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td><strong>Total (roasted)</strong></td>
<td>3</td>
<td>5</td>
<td>1</td>
<td>4</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>7</td>
<td>10</td>
<td>6</td>
<td>8</td>
<td>10</td>
<td>14</td>
</tr>
</tbody>
</table>
Comparison of beef eating quality systems

• None of the systems are perfect
  - Variability of “satisfactory graded” beef is reduced but not removed

• Best delivery of eating quality to consumers:
  - Best: Modification of MSA system
  - Possible: Modification of MLC system

• Best quantity of graded beef:
  - MSA systems would have graded ~80% of beef assessed
  - MLC Blueprint would have passed ~40% of beef
Beef Eating Quality - a European Journey

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- Way forward?
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Recent research
(Literature 2010-2016)

Pre-slaughter and post-slaughter factors

- Genetics, genomics, breed, diet, stress, processing, dry ageing, packaging, tenderisation ...
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Recent research
(Literature 2010-2016)

Managing eating quality

• Instrumental prediction:
  - VIA, MRI, CT scanning, NIR, HSI

• Grading for eating quality:
  - EUROP, USDA, Canadian - evaluation for eating quality
  - MSA or MSA-type systems
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**Instrumental prediction**

(Research 2010-2016)

- Moss et al., 2010 Hyperspectral Imaging (HSI)/ Raman spectroscopy
- Yancey et al., 2010 Visible & Near-Infrared spectroscopy (Vis-NIR)
- ElMasry et al., 2012 HSI
- Roehe et al., 2013 Robotic pH, VIA, CT scanning, ultrasonic fat depth, Vis-NIR, Raman, HSI

*Scottish programme for “Integrated Management of Eating Quality”*

- Font-i-Furnols et al., 2014 Computed Tomography (CT) scanning
- Qiao et al., 2015 Visible Hyperspectral Imaging
- Peng & Dhakal 2015 Optical methods - review
- Lee et al., 2015 Magnetic Resonance Imaging (MRI)
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Instrumental prediction
(Research 2010-2016)

Composition

- **Robotic pH** - robotics work well but pH sensory technology needs improvement
- **VIA** - as good or better than manual grading for saleable meat and carcase fat
- **CT Scanning** - very good for composition, but expensive. Reference method.
- **MRI** - very good for IMF, but not an on-line procedure
- **HSI** - prediction for IMF: $R^2 \sim 70\%$
- **HSI** - variable prediction for fatty acid groups: $R^2 \sim 50-70\%$
- **HSI** - variable prediction of pH: $R^2 \sim 23-73\%$

Moss et al., 2010; ElMasry et al., 2012; Roehe et al., 2013; Lee et al., 2015; Qiao et al., 2015
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**Instrumental prediction**
(Research 2010-2016)

**Eating Quality**

- **Vis-NIR Spectroscopy** -
  - Predicts Shear Force (SSF): $R^2 = 9-50\%$ (dep. days post sl.)
  - Predicts tenderness: $R^2 = 7-46\%$ (dep. muscle)

- **HSI** -
  - Predicts Shear Force (SSF/WBSF): $R^2 = 20-83\%$ (dep. days post sl. & muscle)
  - Predicts tenderness: $R^2 = 7-50\%$ (dep. muscle, lab, ?)
  - Predicts flavour: $R^2 = 32-50\%$ (dep. muscle, lab, ?)

*Moss et al., 2010; ElMasry et al., 2012; Roehe et al., 2013; Qiao et al., 2015*
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Grading for Eating Quality
(Research 2010-2016)

USDA, Canada, EUROP

- USDA - large grade differences are detected by consumers but not lesser ones
  (Tedford 2014; Acheson et al., 2014; O’Quinn et al., 2015; Mateescu et al., 2016)

- Canadian grades did not differentiate on tenderness
  (Puente et al., 2016)

- European conformation and fat scores have no relationship with eating quality
  (Bonny et al., 2016)

Not designed to predict eating quality!
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Grading for Eating Quality
(Research 2010-2016)

MSA or MSA-type systems

- Effective for beef and consumers from
  - Australia, S Korea, S Africa, Japan, NI, ROI, France, Poland

- Adaptations
  - Inclusion of bulls, dairy, different regimes, cooking methods
  - Prediction of flavour quality and characteristics

- Joint European data analysed
  - Ossification better than age at predicting EQ
  - Dairy beef slightly better and bulls slightly poorer
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Grading for Eating Quality

Update on MSA or MSA-type systems world-wide

Australia

- 3.27 million carcasses 2015/16
- 38% of total Australian kill
- Now underpinning most brands
- Premiums est. at $187m (~10%), 15/16

New Zealand

- MSA-type model > “Reserve Brand”
- Premium ~30% in NZ
- Launched ranges in Germany, USA +

Poland

- Polish Beef Association - Polish model developed
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How will the European beef industry deliver eating quality to its consumers?
牛肉食用品质—欧洲之旅

当前的倡议

波兰
- 行业正在创建波兰模式

可能的欧盟项目
- “3G”：全球保障分级
- 整合系统

EuroBeef
- 利用到目前为止的工作来创建工具
- 以满足欧洲牛肉行业的需求
- 将科学和行业结合在一起
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Where next?

Options

1. Continue with retailer/company specs?
   - Is it delivering the consistency needed?

2. Meat Standards Australia
   - Industry is cautious - license fee, complexity, downgraded product

3. Instrumental monitoring on-line
   - Advances in robotics but technology is not yet fully in place

4. New Eating Quality Assurance method?
   - What would it need to deliver?
A new Europe-based Beef Eating Quality System?

**Profitable**
Commercially viable

**Simple**
At point of operation

**Effective**
Delivers better eating quality to consumers

**Flexible**
To support:
- existing and new brands
- commodity and niche products
- new technologies
- environmental/welfare?

Different interpretations for different companies