Lamb Meat Quality

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April 25, 2017

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Lamb Meat Quality

ASI Let’s Grow Webinar
Dr. Travis W. Hoffman
Extension Sheep Specialist
April 25, 2017
American Lamb

• Do we know our bullseye?
• How do we get there?
• Can we do it consistently?

Beginning with the End in Mind!
LAMB: The Trendy Protein
The American Lamb Consumer

- Roughly **40 percent** of consumers have **never eaten lamb**
  - many report they have never had the chance to try it
- **Males** are more likely to be lamb eaters
- **Income** plays a role in lamb consumption
- Lamb consumption linked to **special occasions**

American Lamb Board, 2017
Total US Lamb Sales by Year

Lamb Dollars 2013-2016

Consistent Lamb Dollars and Pounds of sales

Information Resources, Inc./Fresh Look Marketing, 2016
Lamb Retail Growth

In 2016, at retail:
Lamb $: ↑ 1.5%
Lamb lbs: ↑ 3.7%

2017 Easter Special
Bone-in Leg: $5.70/lb.
Rack: $10.85/lb.
Loin Chops: $7.82/lb.
Shoulder Chops: $4.98/lb.

Information Resources, Inc./Fresh Look Marketing, 2016; USDA-AMS, 2017
Lamb retail: % of $ per primal

1. Loin: 25.7%
2. Leg: 20.5%
3. Rack/Rib: 19.1%
4. Shoulder: 17.6%
5. Ground: 9.8%
6. Misc: 7.2%
7. Variety: 0.0%

Information Resources, Inc./Fresh Look Marketing, 2016; American Lamb Board, 2017
Lamb Retail: % of lbs. sold

Preferred cuts:

- Northeast = Leg
- Southeast = Shoulder
- California = Shoulder
- Mid-South = Shoulder
- West = Loin
- Great Lakes = Leg
- South Central = Leg
- Plains = Leg

U.S. per capita consumption = 0.88 lbs.
Top 10 Restaurant Trends in 2017

1) Hyper-local sourcing (e.g. restaurant gardens)
2) Chef-driven fast-casual concepts
3) Natural ingredients/clean menus
4) Environmental sustainability
5) Locally sourced produce
6) Locally sourced meat and seafood

Source: Lamb Menu Study for the American Lamb Board - MenuTrends Datassential 2016
Ethnic Marketing
Ethnic Cuisine

American consumers are adventurous:

• Mediterranean
• Spanish
• Caribbean
• Middle Eastern
• French
• Thai
What is Lamb?

1) Young Sheep (32%)

2) Red Meat Alternative (25%)

3) Delicious and Flavorful Attributes (20%)

4) Delicacy, High End Meat (9%)

5) Healthy Protein (7%)

6) Other (6%)
Retail: Supermarket (n = 31); Butchers (n = 11); Direct/Farmer’s Market (n = 18)

Foodservice: Fine Dining (n = 23); Casual Dining (n = 22); Purveyors (n = 15)
Does American Lamb = Quality?

Are we winning at retail and foodservice?

“You cannot manage, what you don’t measure.”
What are the quality traits (buckets) that drive purchasing decisions at retail/foodservice/purveyor sectors?

- Origin
- Sheep Raising Practices
- Eating Satisfaction
- Weight/Size
- Product Appearance/Composition
- Product Convenience/Form
- Nutrition/Wholesomeness
<table>
<thead>
<tr>
<th>Quality Attribute</th>
<th>Primary Definition</th>
<th>Secondary Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eating Satisfaction (ES)</td>
<td>1) Lamb Flavor/Taste</td>
<td>2) Tenderness</td>
</tr>
<tr>
<td>Origin (ORG)</td>
<td>1) Locally Raised</td>
<td>2) American</td>
</tr>
<tr>
<td>Sheep Raising Practices (SRP)</td>
<td>1) Grass-Fed</td>
<td>2) Humanely Raised</td>
</tr>
<tr>
<td>Product Appearance/Composition (PAC)</td>
<td>1) Lean to Fat Ratio</td>
<td>2) Fresh Lamb Color</td>
</tr>
<tr>
<td>Weight/Size (WS)</td>
<td>1) Consistent Cut Size</td>
<td>2) Consistent Cut Weight</td>
</tr>
<tr>
<td>Nutrition/Wholesomeness (NW)</td>
<td>1) Healthy</td>
<td>2) Lean</td>
</tr>
<tr>
<td>Product Convenience/Form (PCF)</td>
<td>1) Availability</td>
<td>2) Cut Specifications</td>
</tr>
</tbody>
</table>
Lamb Quality Attribute Shares of Preference

- ES: 38.9\%^a
- ORG: 17.2\%^b
- SRP: 13.5\%^c
- PAC: 10.5\%^d
- WS: 8.5\%^e
- NW: 7.1\%^f
- PCF: 4.2\%^g

Percentages lacking a common superscript differ ($P < 0.05$).

Rank and shares of preference (%) for seven quality attributes identified by interview respondents (N = 120) representing retail, foodservice, and purveyor sectors.
Willingness-to-Pay probability for requirement, no premium, willing to pay a premium for seven quality attributes, and average WTP Premium.

<table>
<thead>
<tr>
<th>WTP</th>
<th>ORG</th>
<th>SRP</th>
<th>ES</th>
<th>WS</th>
<th>PAC</th>
<th>PCF</th>
<th>NW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Requirement</td>
<td>25.83%</td>
<td>20.00%</td>
<td>9.17%</td>
<td>13.33%</td>
<td>9.17%</td>
<td>5.83%</td>
<td>1.67%</td>
</tr>
<tr>
<td>No Premium</td>
<td>22.50%</td>
<td>27.50%</td>
<td>19.17%</td>
<td>52.50%</td>
<td>38.33%</td>
<td>55.83%</td>
<td>50.83%</td>
</tr>
<tr>
<td>Willing to Pay a Premium</td>
<td>51.67%</td>
<td>52.50%</td>
<td>71.67%</td>
<td>34.17%</td>
<td>52.50%</td>
<td>38.33%</td>
<td>47.50%</td>
</tr>
<tr>
<td>Average WTP Premium</td>
<td>14.17%</td>
<td>14.17%</td>
<td>18.59%</td>
<td>13.82%</td>
<td>14.88%</td>
<td>12.66%</td>
<td>13.64%</td>
</tr>
<tr>
<td>(n = 62)</td>
<td>(n = 63)</td>
<td>(n = 86)</td>
<td>(n = 41)</td>
<td>(n = 63)</td>
<td>(n = 46)</td>
<td>(n = 57)</td>
<td></td>
</tr>
</tbody>
</table>
Why do people purchase lamb?
Lamb Flavor = Quality Eating Experience
Connection with Farmer/Rancher
Embrace the Pastoral Image & Environmental Stewardship of Lamb
Country of Origin

• Lamb has greater import competition than other competing red meat proteins.

• Do retailers/foodservice/purveyors place an emphasis on country of origin prior to purchasing lamb?
Born, Hatched, and Harvested?
Lamb End Product Quality

Ante-mortem

Meat aroma and flavour

Volatile aroma compounds

Post-mortem

Easy

reactions
If only we could make lambs with big racks and loins, small shoulders and legs? Lamb suits many retail/foodservice markets with a variety of cuts.
Product Uniformity
Age Determination for Lamb

65% of respondents request young lamb; most commonly described as under one year of age as lamb.

“People would rather pay a little more money than buy a bad-flavored, gamey lamb.”

“Absolutely, young lamb is necessary. I tend to gravitate to smaller, younger lambs because I think the flavor is so much better. There is no gamey flavor in young lamb. If bigger lamb tasted that good, I would buy them, but they don't. From a retail standpoint they probably don't look as big, so I understand.”

“The lambs need to be under one year of age. We need to clearly define what lamb is in the U.S.A.”

Hoffman et al., 2015
USDA Grading

**USDA Yield Grade:**
- YG1: 6.01%
- YG 2: 32.71%
- YG 3: 31.56%
- YG 4: 15.43%
- YG 5: 14.28%

**USDA Quality Grade:**
- Prime 7.6%
- Choice: 92.4%

USDA-AMS, 2017
USDA Yield/Quality Grade

Are USDA Yield and Quality Grade standards and application currently meeting the needs of the industry?

USDA Yield Grade: 8.3% of Retailers
USDA Quality Grade: 33.3% of Retailers
Lamb Primal Yield by USDA YG

Subprimal Yield of Cuts Expressed as % of Cold Carcass Weight

Neto et al., 2009
Lamb Primal / Subprimal Cuts

$3.14 / lb * 70 lb carcass weight = $219.80
(USDA, April 21, 2017)

$2.92 $7.47 $5.32 $3.65

$3.75 $1.38 $1.46

Shoulder Rack Loin Leg

Foreshank Breast Flank
Lamb Instrument Grading
### Individual Carcass Data

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harvest Date</td>
<td>1/14/2016</td>
</tr>
<tr>
<td>Quality Grade</td>
<td>289.5</td>
</tr>
<tr>
<td>RFID Number</td>
<td>17597020571</td>
</tr>
<tr>
<td>Confidence</td>
<td>331</td>
</tr>
<tr>
<td>Lot Number</td>
<td>101</td>
</tr>
<tr>
<td>Final Grade</td>
<td>310</td>
</tr>
<tr>
<td>Serial Number</td>
<td>3</td>
</tr>
<tr>
<td>Class</td>
<td>Choice</td>
</tr>
<tr>
<td>Hot Weight</td>
<td>63.1</td>
</tr>
<tr>
<td>Occ</td>
<td>42.3</td>
</tr>
<tr>
<td>Species</td>
<td>Lamb</td>
</tr>
<tr>
<td>Breast Lbs</td>
<td>4.6</td>
</tr>
<tr>
<td>Yield Grade</td>
<td>1.85</td>
</tr>
<tr>
<td>Rack Lbs</td>
<td>7.4</td>
</tr>
<tr>
<td>Cold Weight</td>
<td>62.6</td>
</tr>
<tr>
<td>Shoulder Squ. Lbs</td>
<td>9.6</td>
</tr>
<tr>
<td>Shrink Lbs</td>
<td>6.5</td>
</tr>
<tr>
<td>Leg Lbs</td>
<td>20</td>
</tr>
<tr>
<td>Shrink %</td>
<td>0.79%</td>
</tr>
<tr>
<td>Loin Lbs</td>
<td>5.2</td>
</tr>
<tr>
<td>Cold Weight Date</td>
<td>1/15/2016</td>
</tr>
<tr>
<td>Neck Lbs</td>
<td>2.1</td>
</tr>
<tr>
<td>Cold Weight Location</td>
<td>Fabric Scale</td>
</tr>
<tr>
<td>Trotter Lbs</td>
<td>0.7</td>
</tr>
</tbody>
</table>

Harvest Date: 11/23/2015  Lot #: 101  Serial #: 1
Lamb Cutability
Lamb Fabrication

Is the lamb industry “improving quality with the knife?”

How can we continue to meet consumer specifications and enhance lamb demand?
The Cost of Fat
Lamb Product Dimensions
# Lamb Loin Dimensions at Retail

<table>
<thead>
<tr>
<th>Trait</th>
<th>U.S. (n = 383)</th>
<th>Australia (n = 67)</th>
<th>New Zealand (n = 115)</th>
<th>P - Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Longissimus Dorsi</em> Area</td>
<td>3.03&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.60&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.25&lt;sup&gt;c&lt;/sup&gt;</td>
<td>P &lt; 0.0001</td>
</tr>
<tr>
<td><em>Psoas Major Area</em></td>
<td>1.11</td>
<td>0.91</td>
<td>0.96</td>
<td>P = 0.1839</td>
</tr>
<tr>
<td>Total Area</td>
<td>7.88&lt;sup&gt;a&lt;/sup&gt;</td>
<td>6.41&lt;sup&gt;b&lt;/sup&gt;</td>
<td>6.15&lt;sup&gt;b&lt;/sup&gt;</td>
<td>P &lt; 0.0001</td>
</tr>
<tr>
<td><em>Longissimus Dorsi</em> Width</td>
<td>1.29</td>
<td>1.17</td>
<td>1.18</td>
<td>P &lt; 0.0001</td>
</tr>
<tr>
<td><em>Longissimus Dorsi</em> Length</td>
<td>2.57&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.43&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.18&lt;sup&gt;c&lt;/sup&gt;</td>
<td>P &lt; 0.0001</td>
</tr>
<tr>
<td>Fat – 0% Location</td>
<td>0.26&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.25&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.31&lt;sup&gt;a&lt;/sup&gt;</td>
<td>P = 0.0137</td>
</tr>
<tr>
<td>Fat – 50% Location</td>
<td>0.33&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.25&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.34&lt;sup&gt;a&lt;/sup&gt;</td>
<td>P = 0.0027</td>
</tr>
<tr>
<td>Fat – 100% Location</td>
<td>0.30&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.23&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.34&lt;sup&gt;a&lt;/sup&gt;</td>
<td>P = 0.0122</td>
</tr>
<tr>
<td>Tail Length</td>
<td>0.36&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.18&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.29&lt;sup&gt;b&lt;/sup&gt;</td>
<td>P &lt; 0.0001</td>
</tr>
</tbody>
</table>
Tenderness Evaluation
## Tenderness (Warner-Bratzler Shear Force)

<table>
<thead>
<tr>
<th>Lamb Cut</th>
<th>WBSF</th>
<th>U.S.</th>
<th>Australia</th>
<th>New Zealand</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rib Chop</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.90a</td>
<td>1.52b</td>
<td>1.57b</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.06)</td>
<td>(0.015)</td>
<td>(0.12)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Loin Chop</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.78a</td>
<td>1.51b</td>
<td>1.56b</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.03)</td>
<td>(0.08)</td>
<td>(0.06)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Loin Chop</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.80</td>
<td>1.74</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.04)</td>
<td>(0.03)</td>
<td></td>
</tr>
</tbody>
</table>

- U.S. (n = 71)
- Australia (n = 13)
- New Zealand (n = 22)

**P Value**

- **Rib Chop**: $P = 0.0091$
- **Loin Chop**: $P = 0.0003$
- **Loin Chop (Grass-Fed)**: $P = 0.2126$
Vision for the future!
Solve the Challenge

Lean Meat Yield / Eating Satisfaction / Producer Profitability
Making Magic Happen!
Wool Breeds
Meat Breeds
Hair Breeds
Gate to Rail Data

<table>
<thead>
<tr>
<th>Carcass Wt.</th>
<th># of Head</th>
<th>HCW</th>
<th>FT</th>
<th>BW</th>
<th>REA</th>
<th>% BCTRC</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;86</td>
<td>14</td>
<td>91.31</td>
<td>0.42</td>
<td>1.16</td>
<td>2.52</td>
<td>42.47</td>
</tr>
<tr>
<td>76-85</td>
<td>63</td>
<td>79.88</td>
<td>0.40</td>
<td>0.93</td>
<td>2.51</td>
<td>44.30</td>
</tr>
<tr>
<td>66-75</td>
<td>164</td>
<td>70.98</td>
<td>0.33</td>
<td>0.87</td>
<td>2.46</td>
<td>45.45</td>
</tr>
<tr>
<td>56-65</td>
<td>98</td>
<td>61.84</td>
<td>0.27</td>
<td>0.81</td>
<td>2.16</td>
<td>45.94</td>
</tr>
<tr>
<td>&lt;55</td>
<td>17</td>
<td>50.12</td>
<td>0.25</td>
<td>0.62</td>
<td>1.82</td>
<td>46.89</td>
</tr>
<tr>
<td>Overall</td>
<td>356</td>
<td>69.84</td>
<td>0.32</td>
<td>0.86</td>
<td>2.36</td>
<td>45.33</td>
</tr>
</tbody>
</table>

Live Weight = 137.4 lb.; Dressing Percent = 50.8 %

Held, Ollila, and Hoffman, 2016
NSIP EBVs

- Growth Traits
- Reproduction Traits
- **Carcass Traits:**
  - Loin muscle depth
  - Fat depth
- Wool Traits
- Parasite Resistance
- Indexes
  - Carcass Plus Index
  - USA Hair Index
  - USA Maternal Index
  - USA Range Index
Australia Genetic Trends (2007-14)

- Post-weaning weight
- Lean meat yield
- Carcass eye muscle
- Carcass fat
- Intra-muscular fat
- Shear force
Australian Competition

Animal performance → Carcass measurements → Consumer eating quality

Index = Trait economic values × Genomic testing
Least squares means for lamb flavor attributes between age class (corresponding range of ground cooked patties).

<table>
<thead>
<tr>
<th>Age¹</th>
<th>Lamb flavor Intensity</th>
<th>Off-flavor</th>
<th>Aroma</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lamb</td>
<td>27.38\textsuperscript{a} (16-43)</td>
<td>9.42\textsuperscript{b} (0-28)</td>
<td>29.65 (19-42)</td>
</tr>
<tr>
<td>Yearling</td>
<td>21.44\textsuperscript{b} (12-35)</td>
<td>5.32\textsuperscript{b} (0-26)</td>
<td>31.76 (16-45)</td>
</tr>
<tr>
<td>Mature</td>
<td>24.56\textsuperscript{ab} (14-44)</td>
<td>\textbf{22.56\textsuperscript{a} (1-63)}</td>
<td>29.0 (22-53)</td>
</tr>
<tr>
<td>SEM</td>
<td>1.40</td>
<td>1.84</td>
<td>1.40</td>
</tr>
<tr>
<td>P-Value</td>
<td>0.0151</td>
<td>&lt;0.0001</td>
<td>0.3423</td>
</tr>
</tbody>
</table>

\textsuperscript{a, b, c} Means within column lacking common superscripts differ (P < 0.05).

\textsuperscript{1}Age Lamb = 0 permanent incisors; Yearling = 2 permanent incisors; Mature = 2+ permanent incisors.

Adapted from Maneotis et al., 2016; funded by American Lamb Board
Lamb Flavor Compounds

3-methylindole (skatole)
- 3MI
- Threshold 10 ppb

4-ethyl octanoic acid
- EOA
- Threshold 6 ppb

4-methyloctanoic acid
- MOA
- Threshold 20 ppb

3-methylnonanoic acid
- MNA
- Threshold 650 ppb

Adapted from: Jaborek et al., 2016
Can we sort on lamb flavor?

Independent variables, $R^2$, $C(p)$, stepwise procedure for best-fit regression equations developed to predict lamb flavor.

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>$R^2$</th>
<th>$C(p)$</th>
<th>Variables in model (partial $R^2$)</th>
<th>% accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lamb Flavor Intensity</td>
<td>0.59</td>
<td>5.2850</td>
<td>C490 (0.1901)</td>
<td>84 % Overall</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>C75 (0.1186)</td>
<td>67% Mild</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>C455 (0.0763)</td>
<td>75% Medium</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>C129 (0.0478)</td>
<td>92% Bold</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>C274 (0.0987)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>C22 (0.0372)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>C494 (0.0213)</td>
<td></td>
</tr>
</tbody>
</table>

$R^2 = 0.59$

Adapted from: Maneotis et al., 2016
NDSU/U of M Lamb Research
Which lambs will:
Be the most marketable?
Taste the best?
Be the most tender?
Generate the most $$$?
Eating Satisfaction
Best Management Practices

<table>
<thead>
<tr>
<th>Production Factors</th>
<th>Farm to Fork Mentality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breed</td>
<td>Gaining weight prior to slaughter</td>
</tr>
<tr>
<td>Sex</td>
<td>USDA Yield Grade 2/3</td>
</tr>
<tr>
<td>Diet</td>
<td>Muscular (&gt; REA)</td>
</tr>
<tr>
<td>Age/Maturity</td>
<td>Reduce pre-slaughter stress</td>
</tr>
<tr>
<td>Cutability</td>
<td>Importance of cooking</td>
</tr>
<tr>
<td>Pre-harvest Stress</td>
<td>Identify consumer preference</td>
</tr>
<tr>
<td>Chill rate</td>
<td>Provide Celebrations of Life</td>
</tr>
</tbody>
</table>
EAT AMERICAN LAMB