Understanding lamb finishing systems and their impact on product quality

Richard Ehrhardt
Senior Extension Specialist - Small Ruminants
Michigan State University

Overview:
• Methods of raising market lambs
• Factors that impact growth, feed efficiency and product quality
• Comparison of rearing systems and their economics

Lamb rearing systems:
• Grain feeding: preweaning to market
• Background: slower rate of growth on pasture for variable period of time followed by grain finishing
• Near exclusive pasture rearing: rearing on pasture for all or majority of rearing period-no grain feeding
• Pasture rearing with grain supplement: rearing on pasture and supplementing with grain during the finishing period

Basic concepts of lamb growth
• Bone > muscle >> fat
• Body composition is a function of maturity (degree of mature size), sex, and growth rate
• Lambs with larger mature size potential are leaner at a given body weight than those of smaller mature size potential
• Overall, body composition is remarkably similar between breeds when lambs are compared at the same degree of maturity.

Lamb growth concepts
• Maturity profoundly influences:
  ✓ Growth rate
  ✓ Body composition
  ✓ Feed efficiency

• Lambs of the same size may also differ in the shape of their growth curve and in carcass traits

Lambs at the same size but not maturity:
Polypay vs. Suffolk lamb at 130 lbs

<table>
<thead>
<tr>
<th></th>
<th>Polypay</th>
<th>Suffolk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mature size (lbs)</td>
<td>175</td>
<td>230</td>
</tr>
<tr>
<td>% of mature size</td>
<td>74%</td>
<td>56%</td>
</tr>
<tr>
<td>Muscle (lbs)</td>
<td>33.2</td>
<td>35.4</td>
</tr>
<tr>
<td>Bone (lbs)</td>
<td>8.3</td>
<td>9.2</td>
</tr>
<tr>
<td>Fat (lbs)</td>
<td>23.4</td>
<td>18.4</td>
</tr>
</tbody>
</table>
Polypay vs. Suffolk lamb at same degree of mature size (0.70)

<table>
<thead>
<tr>
<th></th>
<th>Polypay</th>
<th>Suffolk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mature size (lbs)</td>
<td>175</td>
<td>230</td>
</tr>
<tr>
<td>% of mature size</td>
<td>70%</td>
<td>70%</td>
</tr>
<tr>
<td>Liveweight</td>
<td>122</td>
<td>161</td>
</tr>
<tr>
<td>Muscle (lbs, [%BW])</td>
<td>33.0 [27.0]</td>
<td>43.3 [26.9]</td>
</tr>
<tr>
<td>Bone (lbs, [%BW])</td>
<td>8.0 [6.6]</td>
<td>9.6 [6.6]</td>
</tr>
<tr>
<td>Fat (lbs, [%BW])</td>
<td>19.2 [15.8]</td>
<td>24.3 [15.8]</td>
</tr>
</tbody>
</table>

Lamb Feed Efficiency:
- Feed efficiency is influenced by diet, maturity and genetics.
- High efficiency ~3.0 lb feed/lb gain, but may be as poor as 8+ lb feed/lb gain.
- The lean growth phase (accumulation of muscle) is the most efficient. **There is more water and less energy in a pound of muscle than in a pound of fat.**
- Lamb feed efficiency is largely driven by the composition of gain (body composition) and hence hugely influenced by degree of lamb maturity.

Feed efficiency is driven by body fat gain

Body composition and rate of growth:
- Fat has lower priority for energy than does muscle so when animals are feed excess energy the relative partition into fat is greater (fattening diets!)
- Therefore, animals grown more slowly are leaner at any given maturity than those grown more quickly
- **Backgrounding** is a term used for a feeding program designed to limit the rate of growth allowing for a leaner animal at a given stage of maturity (% of mature size).

Plane of nutrition effects how nutrients are partitioned during growth

Sir John Hammond 1944
Lamb finishing concepts:

- Goal is to have adequate fat within muscle (intramuscular fat=marbling) for juiciness and flavor without excessive intermuscular fat (seam fat and subcutaneous fat).
- 4% intermuscular fat content is associated with higher eating quality in lamb.
- Can we optimize genetics and feeding strategies to achieve this goal?

What is reasonable ballpark estimate for lamb size to efficiently create YG 2 (approx. 25% carcass fat)?

- Well fed lambs (wethers and ewes) reach the ideal carcass yield grade at 70% of the average maternal mature size of their sire and dam.

Sire: 330 lb Suffolk ram
Dam: 175 lb PolypayX ewe

Average maternal size: 202.5 lbs
Ideal market lamb size = .7 x 202.5 = 142 lbs

Variations on 70% maternal size rule:

1. Ram lambs can be grown to 75-80% maternal mature size.
2. Slowly grown lambs can be grown to 75% maternal mature size.
   - Grass-fed
   - Background feeding systems

Backgrounding feeding programs:

- Background feeding can be used to create larger market animals that are still relatively lean.
- Backgrounding can be a good or bad strategy depending on:
  - Market price fluctuations
  - Impact of maturity on carcass quality
  - Yardage cost: cost of maintaining an animal in a feeding facility
  - Mortality risk
  - Cost of gain for backgrounding vs. feeding for fast growth

Comparison of annual crops grazed as part of a background rearing system for lambs

<table>
<thead>
<tr>
<th>Crop</th>
<th>Corn</th>
<th>Sudan</th>
<th>Brassica</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADG, lb/day</td>
<td>0.32</td>
<td>0.32</td>
<td>0.38</td>
</tr>
<tr>
<td>Feed Gain</td>
<td>11</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>DMI, % per day</td>
<td>5</td>
<td>5</td>
<td>5.8</td>
</tr>
<tr>
<td>Gain potential per acre</td>
<td>720</td>
<td>700</td>
<td>500</td>
</tr>
<tr>
<td>Cost of crop per acre</td>
<td>287</td>
<td>200</td>
<td>165</td>
</tr>
<tr>
<td>Cost of gain</td>
<td>0.40</td>
<td>0.39</td>
<td>0.33</td>
</tr>
</tbody>
</table>
Challenges with grazing lambs:

- Predation
  - Managed with predator-proof fencing or livestock guard dogs
- Parasite control
  - Managed with careful infection monitoring, grazing management, use of quality forages and judicious use of anthelmintics in combination
- Dietary energy level
  - Manage with selective grazing and/or use of high energy forage species
- Pasture availability: Is there quality pasture available when it is needed?
  - Reserve hay/silage regrowth for grazing
  - Plant annual pastures or use cover crop grazing

Grazing management to maximize lamb growth:

- **Maximizing intake is the key** and is managed by controlling pasture allowance
- Do you seek maximum individual lamb gain or maximum gain per acre?
- If finishing lambs on pasture, you may seek maximum individual gain but if backgrounding, then you are seeking maximum gain per acre.
- High intakes are achieved by:
  - Grazing highly digestible forage
  - Short grazing bouts
  - Greater allowance
  - Allows greater selectivity but will decrease quality over time

Lamb* gain on pasture according to forage quality and month of the year (Ehrhardt and Cassida, unpublished)

<table>
<thead>
<tr>
<th>Average daily gain, lbs/d</th>
<th>Forage allowance per day, lb DM/100 lb BW</th>
<th>TDN of forage, % (DM basis)</th>
<th>Month</th>
<th>Pasture specie(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.65</td>
<td>10</td>
<td>66</td>
<td>July-Aug</td>
<td>Leafy brassica</td>
</tr>
<tr>
<td>0.60</td>
<td>10</td>
<td>64</td>
<td>July-Aug</td>
<td>Red clover, ryegrass</td>
</tr>
<tr>
<td>0.45</td>
<td>10</td>
<td>60</td>
<td>July-Aug</td>
<td>BMR Sudan</td>
</tr>
<tr>
<td>0.55</td>
<td>10</td>
<td>62</td>
<td>Sept-Oct</td>
<td>Brassica mix</td>
</tr>
<tr>
<td>0.40</td>
<td>10</td>
<td>62</td>
<td>Nov-Dec</td>
<td>Brassica mix</td>
</tr>
<tr>
<td>0.86</td>
<td>NA</td>
<td>80</td>
<td>All year**</td>
<td>Unlimited grain</td>
</tr>
</tbody>
</table>

* Dorset-cross wether lambs at 0.5 to 0.6 maturity
** Lamb gain can be lower in summer in feedlot under high heat conditions
Patterns of perennial grass growth in New York

- Pattern varies within a growing season due to temperature, rainfall/irrigation, application of fertilizers, grazing/harvest management.
- Growth slumps in late summer when greater mass and quality are needed for lamb grazing.
- Selective grazing can be a solution but in most commercial operations, stocking rates on permanent pasture limit this option.

High energy forages that fill the late summer/fall gap:

- BMR sorghum sudan 58-64
- Alfalfa and clover 58-66
- Alfalfa or Berseem 62-68
- Brassica 60-68
- Grass crops 55-66

What about expanding your grazing onto neighboring land to finish lambs?

- Most of the high quality forage finishing options (especially brassicas) work well as cover crops and can be high yielding after small grain harvest.

Benefits of cover crop grazing:

- Sheep farmer:
  - Inexpensive, quality forage
  - Parasite-free grazing
  - Resting of permanent pastures
  - Extended grazing into winter
- Crop farmer:
  - Retention of soil nutrients
  - Erosion control
  - Enhanced residue recycling
  - Weed control

Objectives

To examine the growth performance, carcass, and meat quality of lambs reared on four rearing systems:

- Four treatments: N=15 lambs per treatment
  - GRN - Grain feedlot diet, 6 wks
  - BKG - 4 wks on pure brassica seeded cover crop, then 4 wks grain feedlot diet
  - BRO - Pure brassica seeded cover crop, 8 wks
  - MIX - Brassica cover crop mix, 8 wks

Seed Mix

<table>
<thead>
<tr>
<th>Species</th>
<th>% Mix</th>
<th>Species</th>
<th>% Mix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brassica Mix 2019</td>
<td></td>
<td>Diverse Mix 2019</td>
<td></td>
</tr>
<tr>
<td>Rape 26</td>
<td>2.5</td>
<td>Rape 26</td>
<td>2.5</td>
</tr>
<tr>
<td>Radish 48</td>
<td>5</td>
<td>Radish 26</td>
<td>5</td>
</tr>
<tr>
<td>Turnip 26</td>
<td>2.5</td>
<td>Turnip 26</td>
<td>2.5</td>
</tr>
<tr>
<td>Pearl Millet 2.5</td>
<td></td>
<td>Pearl Millet 2.5</td>
<td></td>
</tr>
<tr>
<td>Japanese Millet 2.5</td>
<td></td>
<td>Japanese Millet 2.5</td>
<td></td>
</tr>
<tr>
<td>Berseem 7.5</td>
<td></td>
<td>Berseem 7.5</td>
<td></td>
</tr>
<tr>
<td>Clover 25</td>
<td></td>
<td>Clover 25</td>
<td></td>
</tr>
<tr>
<td>Field Pea 35</td>
<td></td>
<td>Field Pea 35</td>
<td></td>
</tr>
<tr>
<td>Oats 17.5</td>
<td></td>
<td>Oats 17.5</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Species</th>
<th>% Mix</th>
<th>Species</th>
<th>% Mix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brassica Mix 2020</td>
<td></td>
<td>Diverse Mix 2020</td>
<td></td>
</tr>
<tr>
<td>Rape 26</td>
<td>2</td>
<td>Rape 26</td>
<td>2</td>
</tr>
<tr>
<td>Radish 26</td>
<td>5</td>
<td>Radish 26</td>
<td>5</td>
</tr>
<tr>
<td>Turnip 26</td>
<td>2</td>
<td>Turnip 26</td>
<td>2</td>
</tr>
<tr>
<td>Pearl Millet 2</td>
<td></td>
<td>Pearl Millet 2</td>
<td></td>
</tr>
<tr>
<td>Japanese Millet 14</td>
<td></td>
<td>Japanese Millet 14</td>
<td></td>
</tr>
<tr>
<td>Berseem 14</td>
<td></td>
<td>Berseem 14</td>
<td></td>
</tr>
<tr>
<td>Clover 23</td>
<td></td>
<td>Clover 23</td>
<td></td>
</tr>
<tr>
<td>Field Pea 33</td>
<td></td>
<td>Field Pea 33</td>
<td></td>
</tr>
<tr>
<td>Oats 33</td>
<td></td>
<td>Oats 33</td>
<td></td>
</tr>
<tr>
<td>Rye 16</td>
<td></td>
<td>Rye 16</td>
<td></td>
</tr>
</tbody>
</table>
Feedlot and Grazing Management

**Feedlot**
- Lambs were fed a transition diet from pasture to grain
- Unlimited feed at minimum 20% refusal
- 6 weeks grain feeding for GRN
- 4 weeks grain feeding for BKG

**Grazing**
- Lambs grazed for 6-8 day periods
- Paddock biomass estimated weekly
- Paddock size was calculated weekly to provide a daily forage DM allowance of 9-10% of the pen's bodyweight

Slaughter

- GRN slaughtered after 6-weeks of treatment
- BKG, BRO, MIX slaughtered after 8-weeks of treatment
- Lambs slaughtered 22 h after last weight measurement
- All carcass data was collected 24 h post slaughter

Carcass Measurements

- Loin Eye Area
- Back Fat Depth
- Eye Muscle Depth
- 12th Rib
- Body Wall Depth

Meat Analyses

- **Physical Analyses**
  - Cooking Loss
  - Color
  - Shear Force
- **Chemical Analyses**
  - Protein
  - Moisture
  - Fat
  - pH

Sensory Analysis

- 100 point continuous scale
- Liking
- Flavor
- Tenderness
- Acceptability
- Loin chops served in halves in individual containers
- Each panelist tried samples from each treatment

Botanical Composition

- Botanical Composition
  - Forbs
  - Cool Season Grass
  - Legumes
  - Warm Season Grass
  - Weeds

- [% of Treatment]
Average Daily Gain

Gain / unit land

Intake (DMI) and feed efficiency (FCR) for Grain Diets

Carass measurements

Meat physical and chemical analyses

Sensory Evaluation
Economics of Lamb Finishing Systems

Summary

- Lambs on grain diets grew faster and had greater carcase weight and fatness than those grazing.
- Lambs on background rearing system exhibited marked compensatory growth and improved feed efficiency over those fed grain exclusively.
- All lambs graded choice or better with grain-fed lambs having greater yield grade than those grazing.
- Loin chops from grazing CC were darker with a deeper red color.
- Intramuscular fat content (marbling) was in the range of 3.8-4.2% and did not differ between treatments.
- Consumer sensory analysis revealed a preference for loin chops of lambs reared on brassica cover crop over those fed an exclusive grain diet in terms of juiciness and flavor.
- Cost of gain was similar for pasture-reared and background lambs but the total profit over the finishing period was ~25% greater for background lambs at current prices.

Thank you

MSU:

- Project Leaders: Kim Cassida and Richard Ehrhardt
- Project Collaborators: Erin Recktenwald, Jeannine Schweihofer, Andrea Garmyn
- Technical Staff: Barbara Makela and Joe Paling
- Farm and meat lab staff: Larry Ojeda, Tony Boughton, Kristen Foster, Wes Mays, Trenton Cole, and Jennifer Dominquez
- Students: Maci Kubik, Carol Freitas, Danny Schaub, Allison Schafer, Alexis Stachurski, Grace Herkimer

Project Cooperators:

- Dale Brooks, Wolverine Packing
- Doug Brooks, United Producers Incorporated
- Funding: Michigan Alliance for Animal Agriculture

Richard Ehrhardt Ph.D.
Email: ehrhard5@msu.edu
Office: (517) 353-2906
Cell: (517) 899-4000