

# **Understanding lamb finishing systems and their impact on product quality**

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# Overview:

- Methods of raising market lambs and the diversity of lamb markets in North America
- 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 for variable periods of time followed by grain finishing

# **There is a great diversity of lamb markets in North American: US examples**

- 1. Milk-fed lambs: Italian market (16-22 kg); Orthodox market (24-32 kg).**
- 2. Lambs for halal slaughter (30-50 kg)**
- 3. Large, finished lambs, traditional market, USDA grading system (55-70 kg)**



**Each market has unique body composition targets with the lighter lamb market standards less well defined**

**Milk fed lambs, 16-32 kg:**

- **Age: sold at weaning or within 6 weeks post weaning at >50% of maturity.**
- **Premiums are paid for lambs with higher body fatness which is achieved by higher growth rates (>275 g/d).**
- **Carcass fatness >14%**



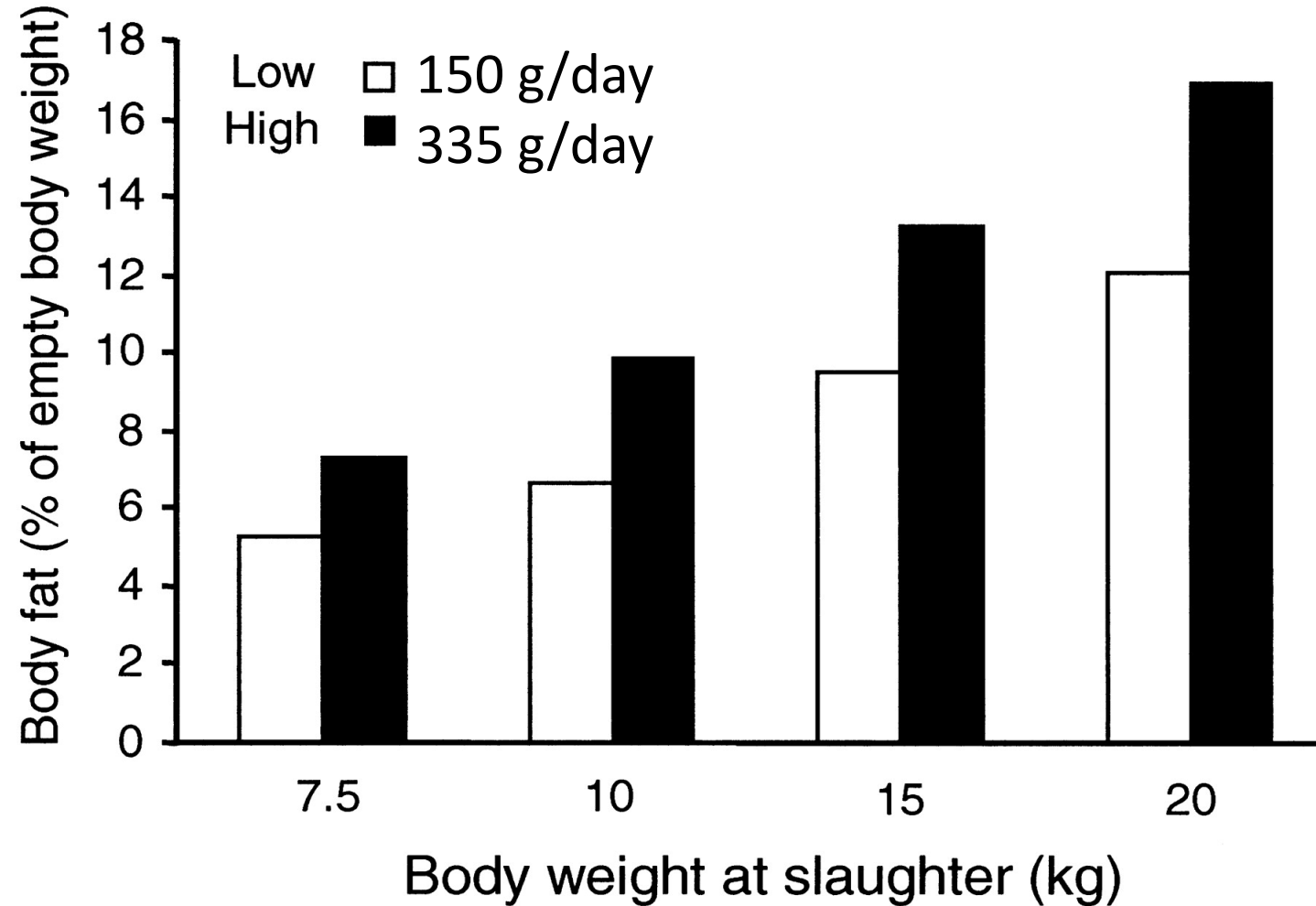








## Plane of nutrition effects how nutrients are partitioned during growth



Ehrhardt R A et al. J. Nutr. 2003;133:4196-4201

## **Lambs for halal slaughter, 30-50 kg:**

- **Age: sold post weaning, lower body fatness acceptable**
- **Lambs generally sold at <60% maturity so they are leaner than larger lambs**
- **Can be grown more slowly and still meet market preferences**





# **Lambs for traditional US market, 55-70kg:**

- **Greater fatness sought than in lighter lambs**
- **The best standard for marketing size is to grow them to a standardized degree of maturity =70%**
- **Lambs at 70% maturity average 25% carcass fatness**
- **Adjustments to the 70% maturity standard are made based on sex and rate of growth.**
  - **Intact males can be sold at 75%**
  - **Slow grown/background lambs can be sold at 75%**



# 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 proportion of mature size.

# Effects of sex on growth and composition of gain in lambs:

	Ewes	Wethers	Rams
Average daily gain (g/d)	310	320	<b>400</b>
Feed:gain	4.8	4.2	<b>3.9</b>
Carcass weight (kg)	22.2	23.0	<b>24.2</b>
Protein accretion (g/d)	25	27	<b>33</b>
Fat accretion (g/d)	135	124	<b>104</b>

# What are the negatives of keeping males intact?

- Meat flavor and tenderness eventually are compromised  
>7 month months of age?
- Marketing males intact <5 months of age is generally advantageous in terms of growth and feed efficiency
- Growing intact males >5 months of age requires separate housing from ewe lambs

# Lamb growth concepts

- Maturity profoundly influences:
  - ✓ Growth rate
  - ✓ Body composition
  - ✓ Feed efficiency

# Lambs at the same size but not maturity:

## *Polypay vs. Suffolk lamb at 59 kg*

	<u>Polypay</u>	<u>Suffolk</u>
Mature size, kg	80	105
% of mature size	74%	56%
Muscle, kg	15	16
Bone, kg	3.8	4.2
Fat, kg	<b>10.6</b>	<b>8.4</b>

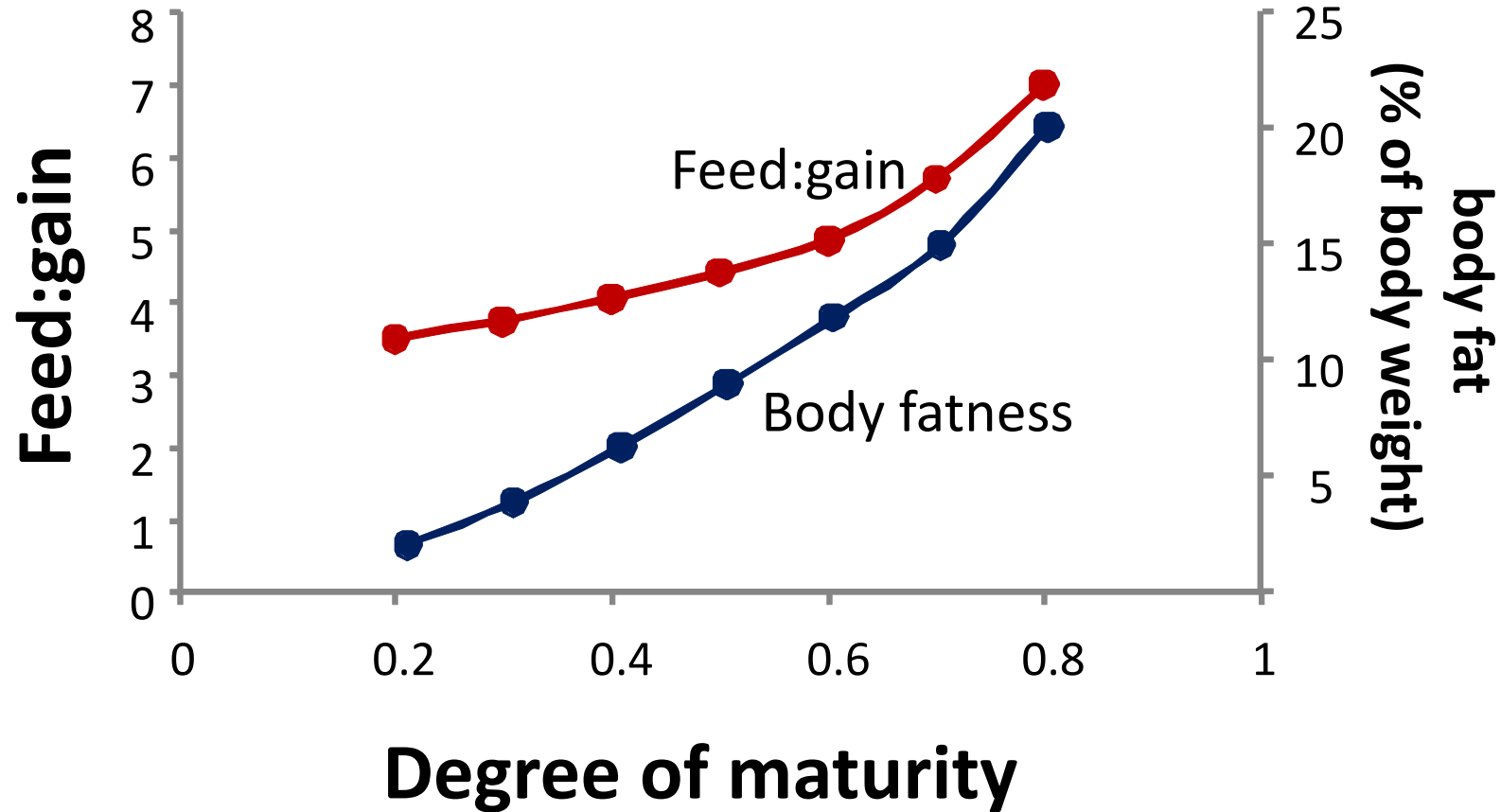
# Polypay vs. Suffolk lamb at same degree of maturity (0.70)

	<u>Polypay</u>	<u>Suffolk</u>
Mature size, kg	80	105
% of mature size	70%	70%
Liveweight	<b>56</b>	<b>73.5</b>
Muscle (lbs, [%BW])	15 [26.8]	19.7 [26.8]
Bone (lbs, [%BW])	3.6 [6.6]	4.4 [6.6]
Fat (lbs, [%BW])	8.7 [15.8]	11 [15.8]

# 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.

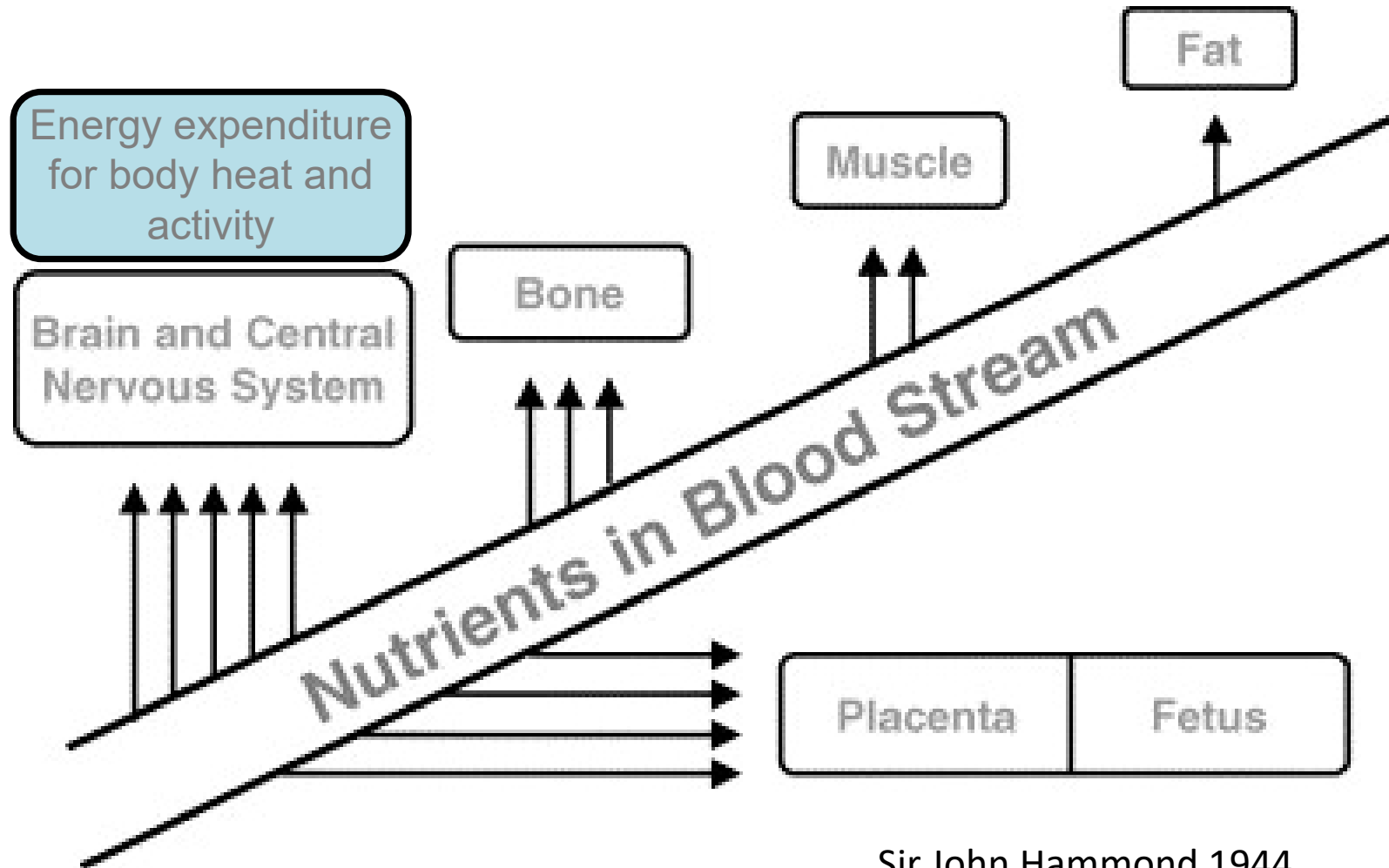
# Feed efficiency is driven by body fat gain





# Body composition and rate of growth:

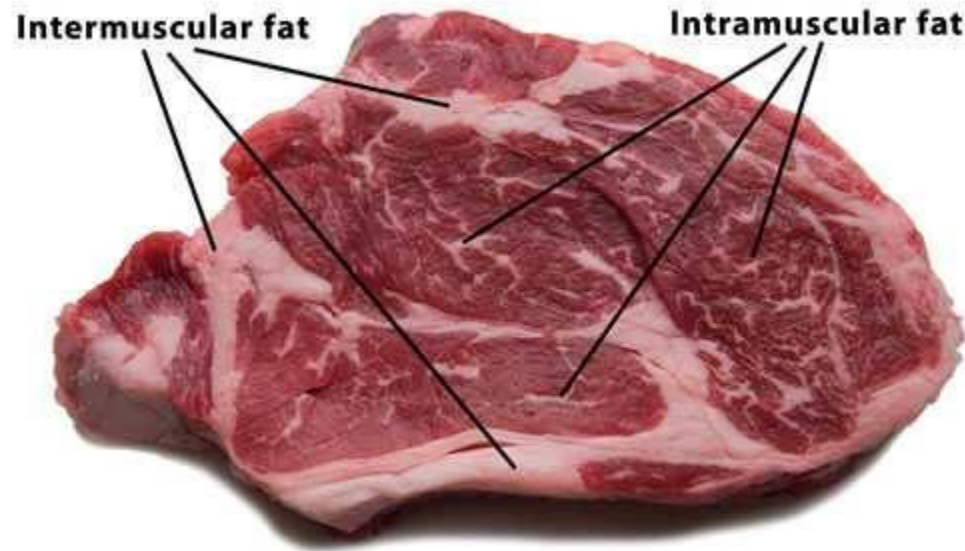
- Fat has lower priority for energy than does muscle so when animals are feed excess energy the relative partition into fat is greater (fattening diets!)
- Therefore, animals grown more slowly are leaner at any given maturity than those grown more quickly
- **Backgrounding** is a term used for a feeding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



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).
- Can we optimize genetics and feeding strategies to achieve this goal?



# 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















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# Challenges with grazing lambs:

- Predation
  - ✓ Managed with predator deterrent fencing and/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 field 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

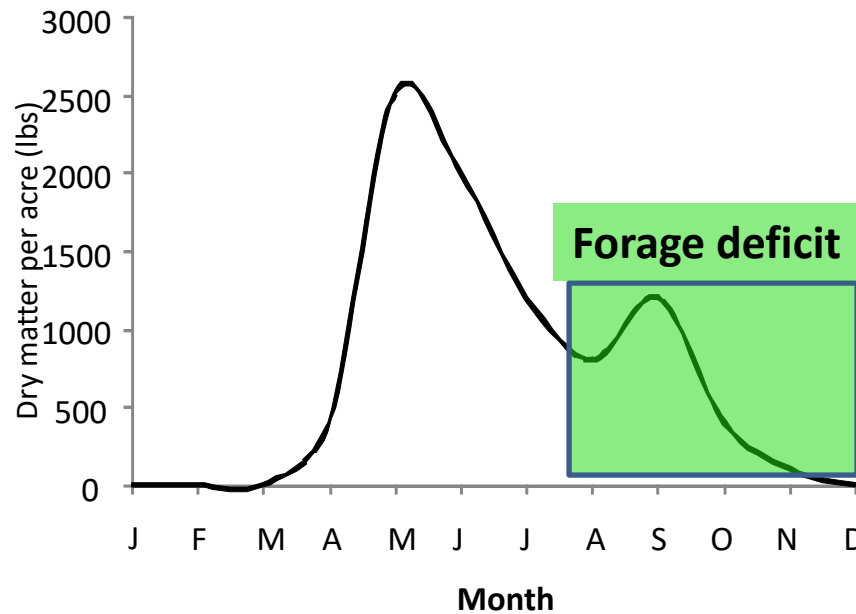
(Ehrhardt and Cassida, unpublished)

Average daily gain, g/d	Forage allowance per day, kg DM/100 kg BW	ME of forage, Mcal/kg (DM basis)	Month	Pasture specie(s)
296	10	2.4	July-August	Leafy brassica
272	10	2.3	July-August	Red clover, ryegrass
204	10	2.15	July-August	BMR Sudan
250	10	2.2	Sept-Oct	Brassica mix
182	10	2.2	Nov-Dec	Brassica mix
390	NA	2.9	All year**	Unlimited grain

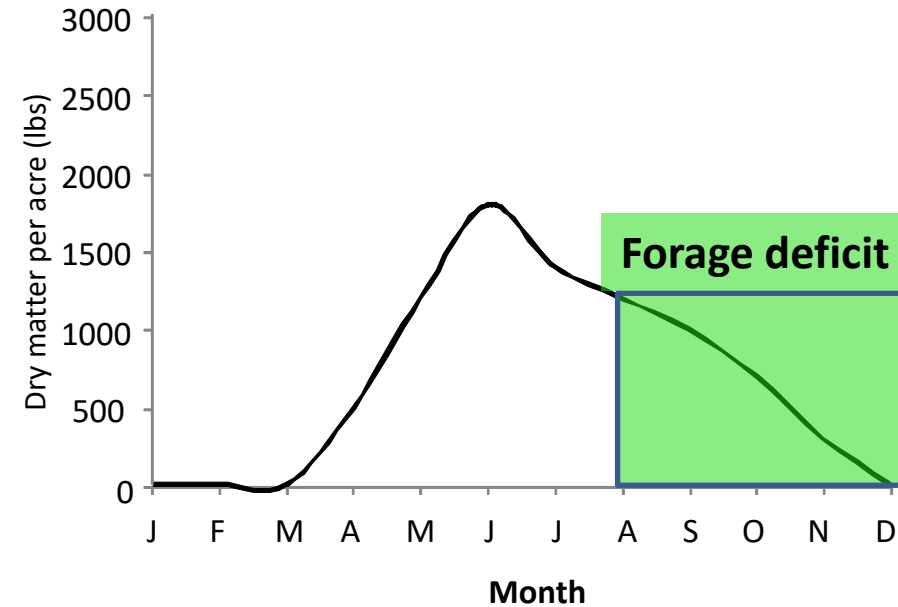
\*Dorset-cross wether lambs at 0.5 to 0.6 maturity

\*\* Lamb gain can be lower in summer in feedlot under high heat conditions

# Patterns of perennial grass growth in Michigan



Orchard Grass on Sandy Loam



Blue Grass on Organic/Muck

- Pattern varies within a growing season due to temperature, rainfall/irrigation, application of fertilizer, 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:

	Aug	Sept.	Oct.	Nov.	Dec.	TDN
BMR sorghum sudan	<div></div>	<div></div>				58-64
Alfalfa and chicory	<div></div>	<div></div>	<div></div>			58-66
Alfalfa or Birdsfoot Trefoil	<div></div>	<div></div>	<div></div>			58-66
Corn	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	62-68
Brassicas	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	60-68
Grass silage	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	55-66

# Annual forages can be part of a forage crop rotation for sheep production

- Concept referred to as a ***“complimentary forage system”***
- Rotation is farm-specific based on forage needs, production system, climate, soils, etc.
- Example:
  - ✓ 30% of land is in perennial forage (grazing or machine harvest)
  - ✓ 70% of remaining land in on a 8 year complimentary forage rotation

Paddock	Year of rotation							
	1	2	3	4	5	6	7	8
<b>A</b>	Perennial forage	Perennial forage	Perennial forage	Perennial forage	Perennial forage	Perennial forage/Rape	Clover/Forbs	Clover/Forbs
<b>B</b>	Clover/Forbs	Perennial forage	Perennial forage	Perennial forage	Perennial forage	Perennial forage	Perennial forage/Rape	Clover/Forbs
<b>C</b>	Clover/Forbs	Clover/Forbs	Perennial forage	Perennial forage	Perennial forage	Perennial forage	Perennial forage	Perennial forage/Rape
<b>D</b>	Perennial forage/Rape	Clover/Forbs	Clover/Forbs	Perennial forage	Perennial forage	Perennial forage	Perennial forage	Perennial forage
<b>E</b>	Perennial forage	Perennial forage/Rape	Clover/Forbs	Clover/Forbs	Perennial forage	Perennial forage	Perennial forage	Perennial forage
<b>F</b>	Perennial forage	Perennial forage	Perennial forage/Rape	Clover/Forbs	Clover/Forbs	Perennial forage	Perennial forage	Perennial forage
<b>G</b>	Perennial forage	Perennial forage	Perennial forage	Perennial forage/Rape	Clover/Forbs	Clover/Forbs	Perennial forage	Perennial forage
<b>H</b>	Perennial forage	Perennial forage	Perennial forage	Perennial forage	Perennial forage/Rape	Clover/Forbs	Clover/Forbs	Perennial forage

# What about expanding your grazing onto neighboring land to grow lambs?

- Cover crops are high quality forages and can be high yielding after especially after small grain harvest (August planting in upper Midwest USA)

## 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





# Animals and Design:

- Randomized complete block with 3 replications of pen/pasture per treatment
- All lambs born in late May/early June, weaned in late July, placed on treatment in early October at 91 lb (41 kg)
- 5 Dorset x Polypay wether lambs per replicate: 2019
- 4 Dorset x Polypay wether lambs and 1 ewe per replicate: 2020
- 3 Dorset x Polypay and 2 Suffolk x (Dorset x Polypay) per rep.: 2021

# Seed Mix

Brassica Mix 2019		Diverse Mix 2019		Brassica Mix 2020		Diverse Mix 2020	
Species	% Mix	Species	% Mix	Species	% Mix	Species	% Mix
Rape	26	Rape	2.5	Rape	26	Rape	2
Radish	48	Radish	5	Radish	48	Radish	5
Turnip	26	Turnip	2.5	Turnip	26	Turnip	2
		Pearl Millet	2.5			Pearl Millet	2
		Japanese Millet	2.5			Japanese Millet	2
		Berseem Clover	7.5			Berseem Clover	14
		Field Pea	25			Field Pea	23
		Oats	35			Oats	33
		Rye	17.5			Rye	16

# Live Animal Measurements

## Body Weight

- Weekly
- Weighed in field for cover crop treatments
- Weighed in barn for grain diets

## Fecal Samples:

- Prior to treatment after combination drench treatment

## Blood Sample

- Collected at week -1, 4, 6 (GRN only), 8 (all other treatments)
- Hematocrit (PCV)
- Plasma stored for metabolite analysis





# 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

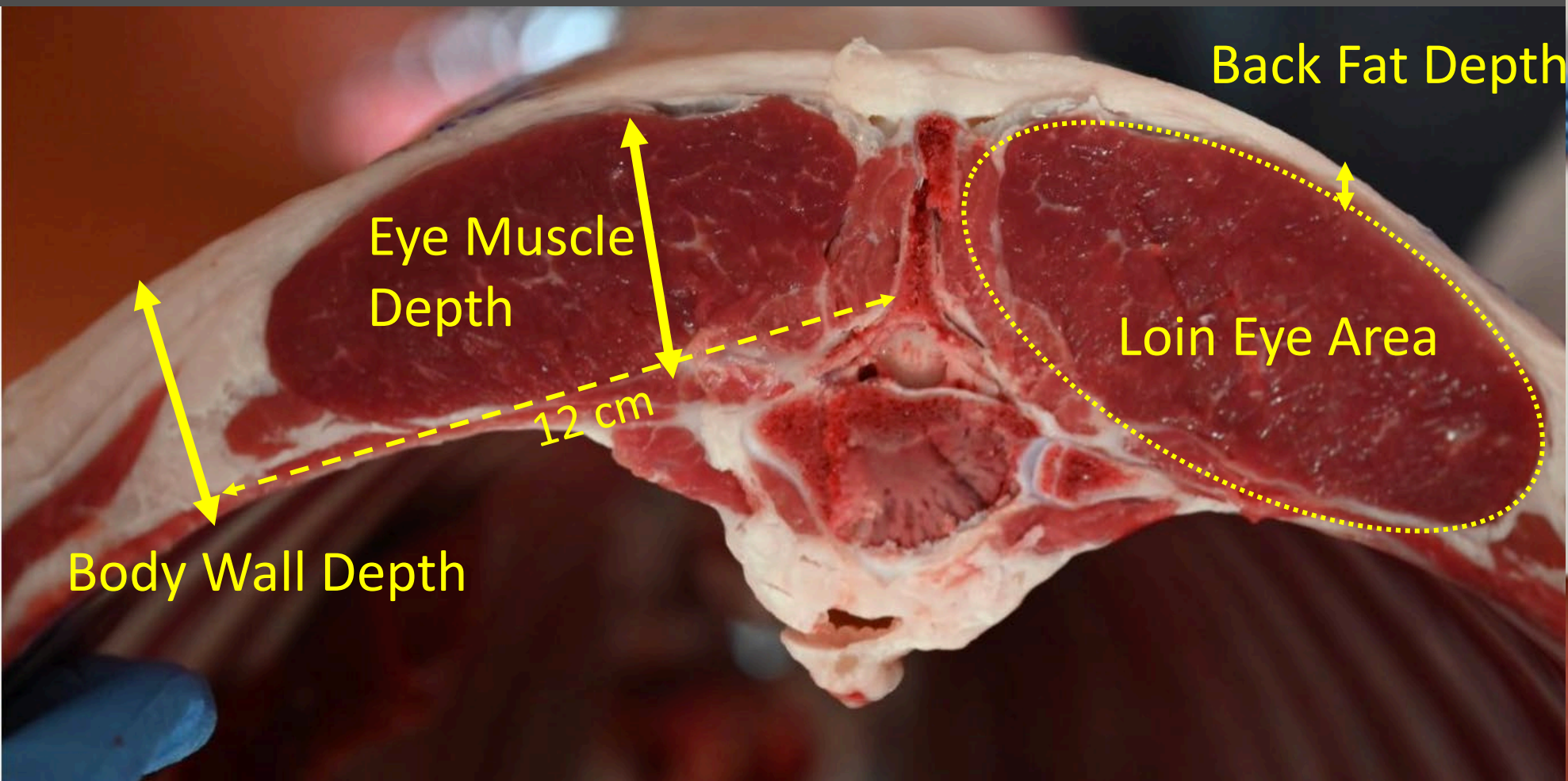
- GRN slaughtered after 6-weeks of treatment
- BKG,BRO, MIX slaughtered after 8-weeks of treatment
- Lambs slaughtered 22 h after last weight measurement
- All carcass data was collected 24 h post slaughter



**Wolverine**  
**Packing Co.**



# Carcass Measurements



# Meat Analyses



## Physical Analyses

- Cooking Loss
  - Loins cooked to 158 F
  - George Foreman Grill
- Color
  - 3 chops measured
  - Hunter Miniscan XE Plus
- Shear force
  - 24 hours post cooking
  - Warner Bratzler Shear Force

## Chemical Analyses

- Analyzed at Texas Tech with Andrea Krieg
- FOSS Analyzer
  - Protein
  - Moisture
  - Fat
- pH



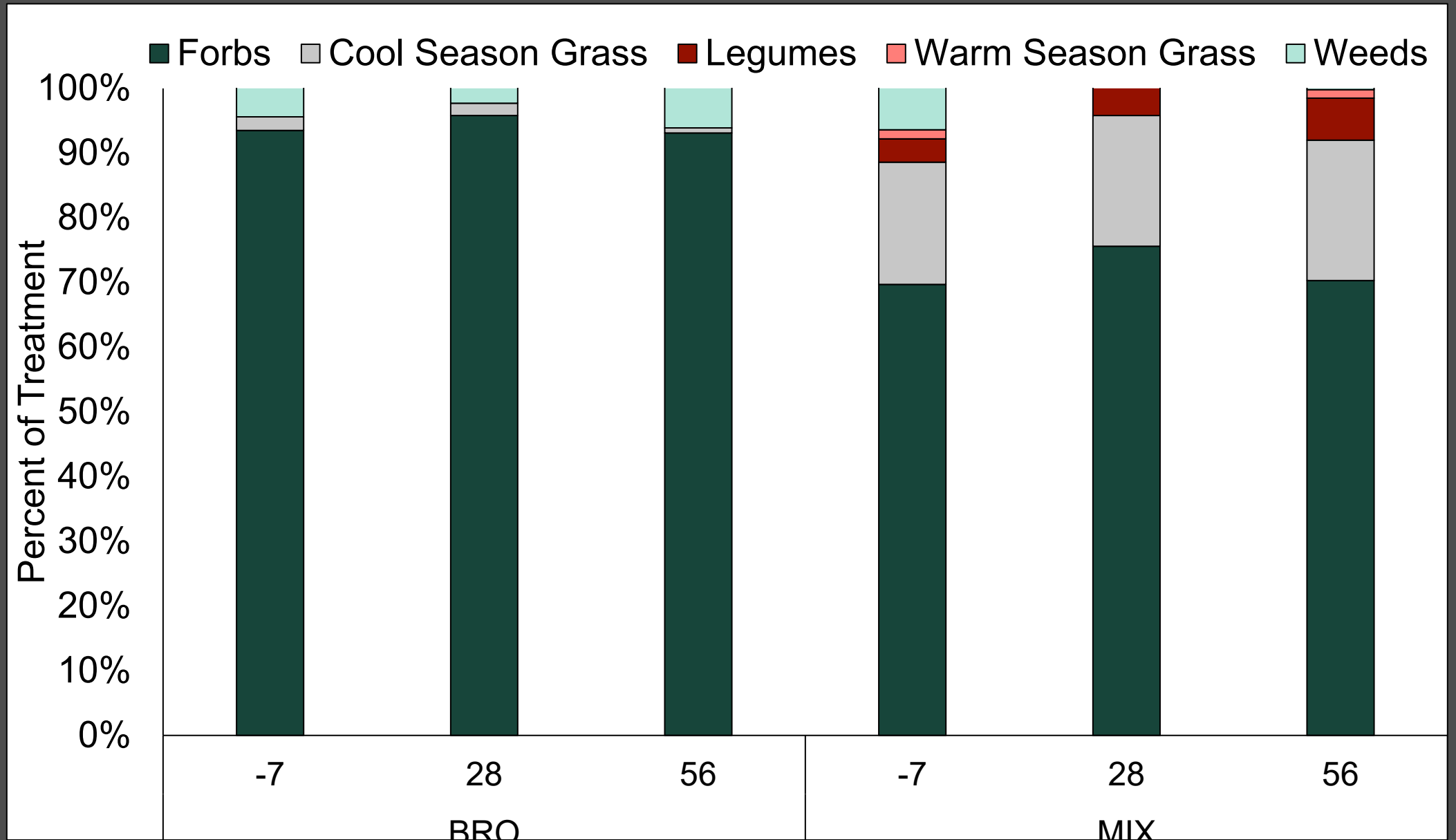
# Sensory Analysis

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

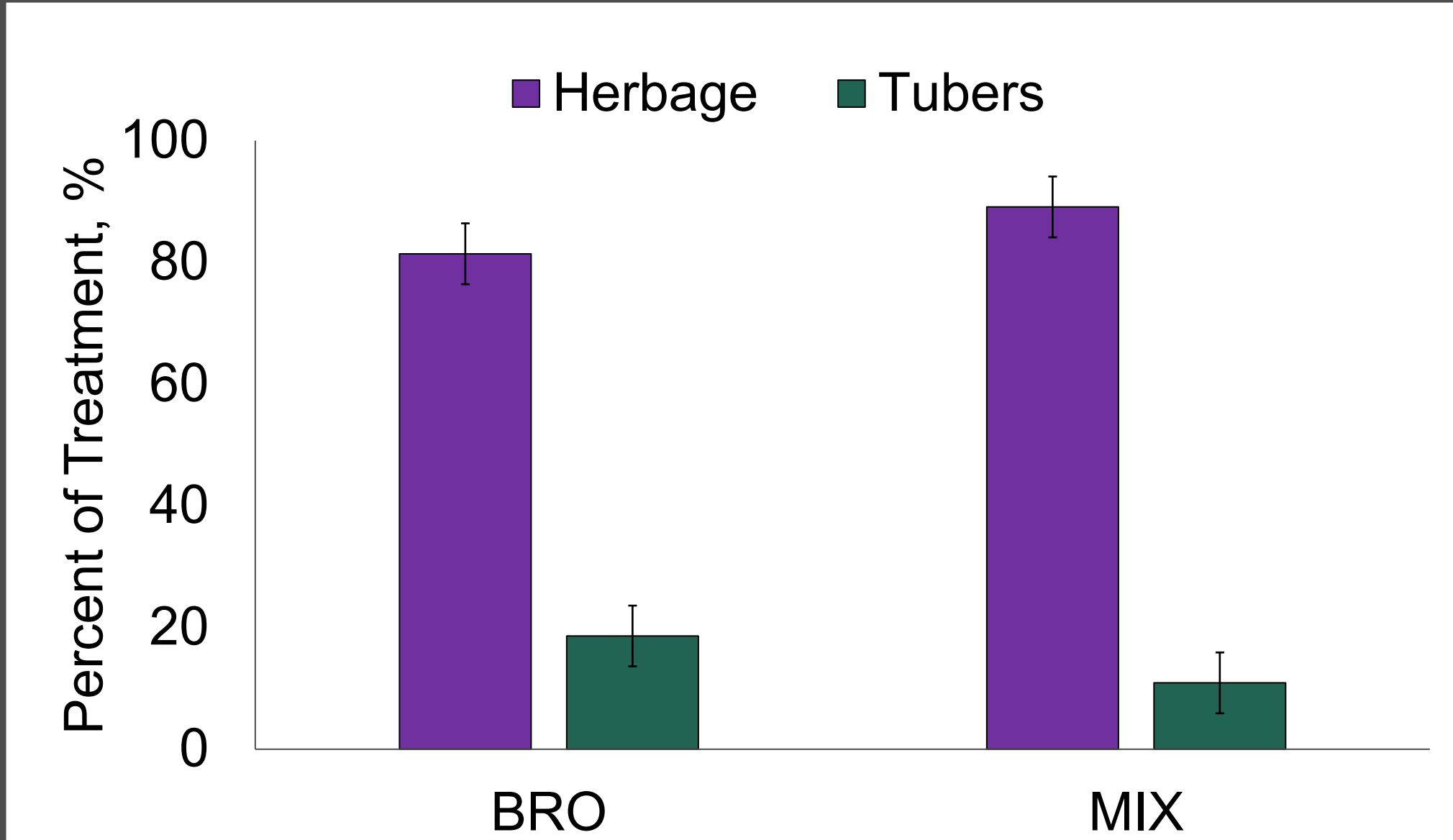




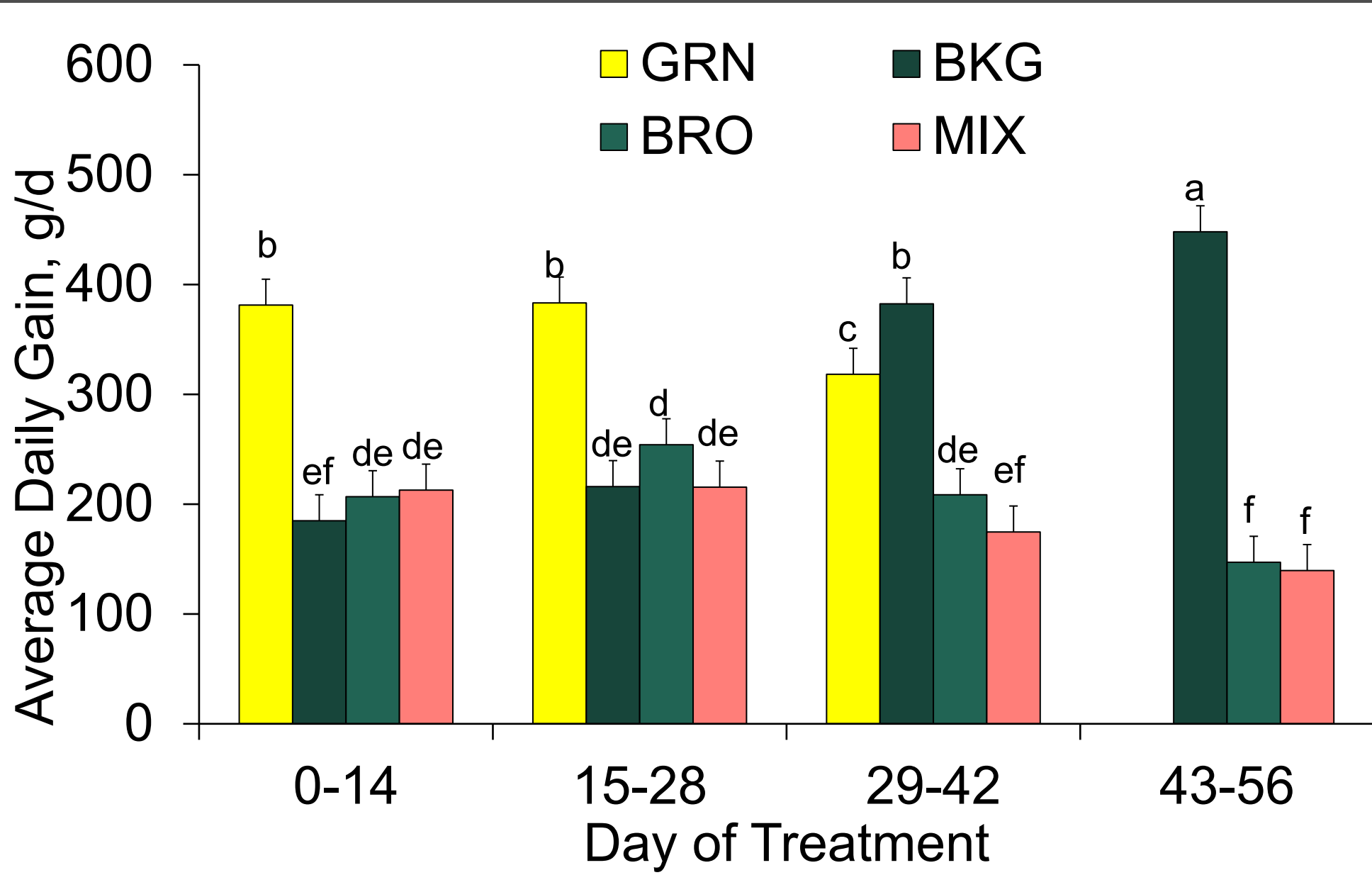
# Botanical Composition



# Proportion of herbage vs. tubers

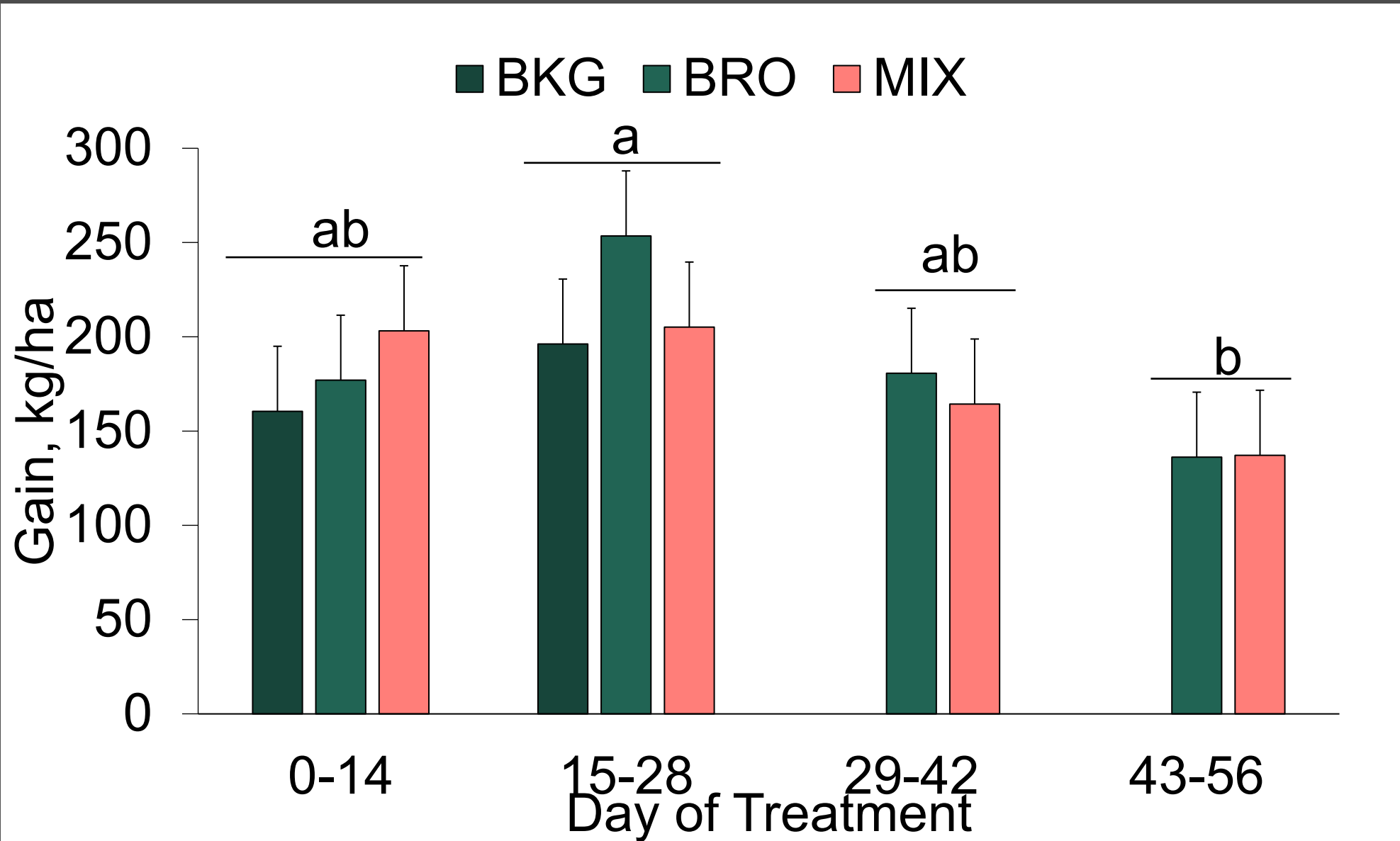


# Average Daily Gain

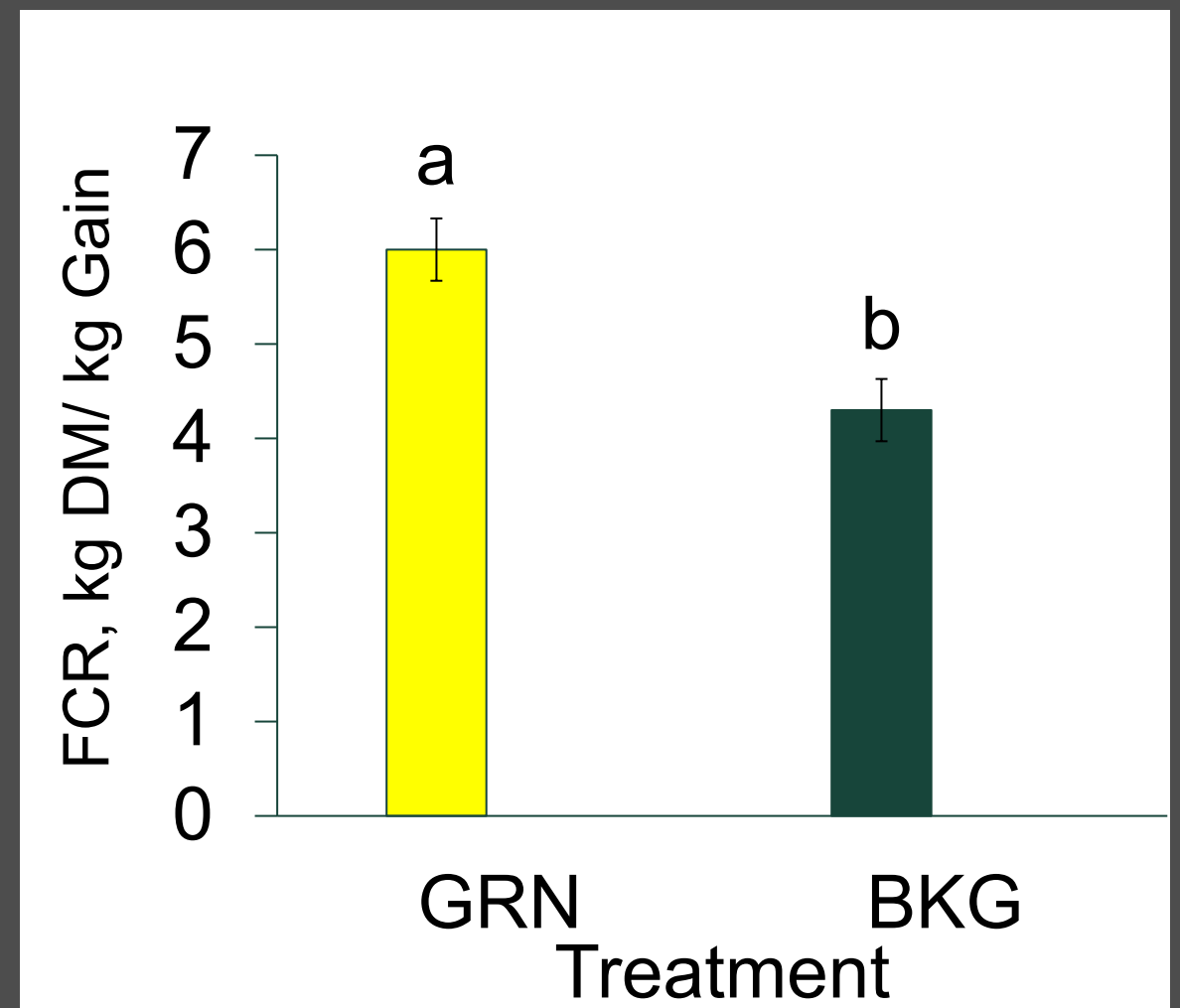
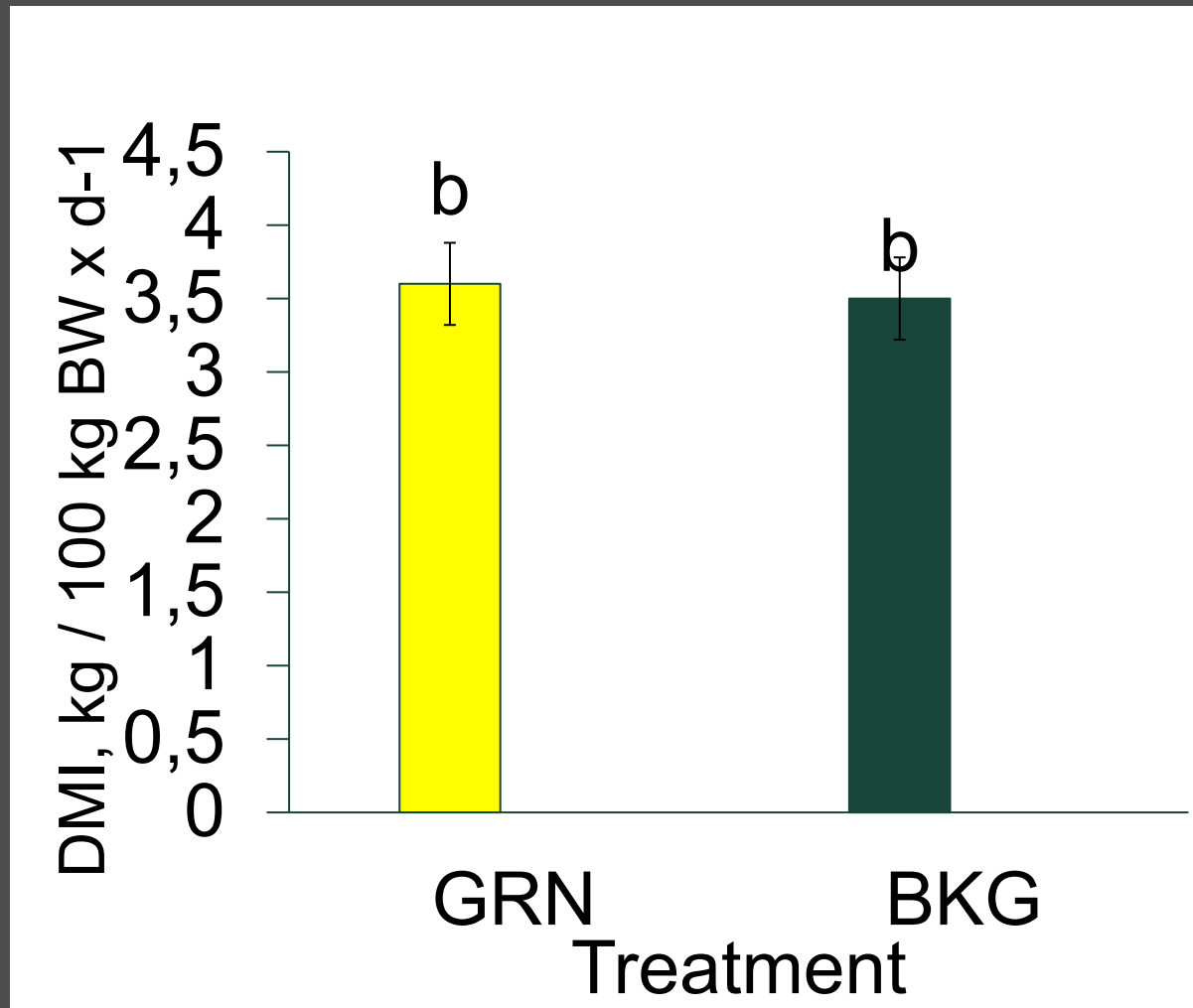




# Gain / unit land



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



# Carcass measurements

Carcass traits of lambs on reared on various treatments.					
	Treatments				
Carcass Trait	GRN	BKG	BRO	MIX	SE
Hot Carcass Weight, kg	29.8 <sup>a</sup>	30.2 <sup>a</sup>	27.9 <sup>b</sup>	27.3 <sup>b</sup>	1.29
Back Fat Depth, cm	0.45 <sup>ab</sup>	0.51 <sup>a</sup>	0.40 <sup>bc</sup>	0.38 <sup>c</sup>	0.03
Body Wall Fat Depth, cm	2.28 <sup>a</sup>	2.35 <sup>a</sup>	1.95 <sup>b</sup>	1.92 <sup>b</sup>	0.14
Loin Eye Area, cm	20.6 <sup>a</sup>	20.0 <sup>ab</sup>	19.1 <sup>bc</sup>	18.7 <sup>c</sup>	1.09
Eye Muscle Depth, cm	3.77 <sup>a</sup>	3.52 <sup>b</sup>	3.40 <sup>c</sup>	3.37 <sup>c</sup>	0.04
Yield Grade	2.16 <sup>ab</sup>	2.37 <sup>a</sup>	1.98 <sup>bc</sup>	1.86 <sup>c</sup>	0.10
Quality Grade	3.00 <sup>a</sup>	2.20 <sup>b</sup>	1.67 <sup>b</sup>	1.83 <sup>b</sup>	0.20
Dressing Percentage, %	51.5	50.6	51.8	51.5	1.29



# Meat physical and chemical analyses

**Cooking Loss, proximate and Warner-Bratzler shear force (WBSF), color and pH values of lamb on different rearing treatments.**

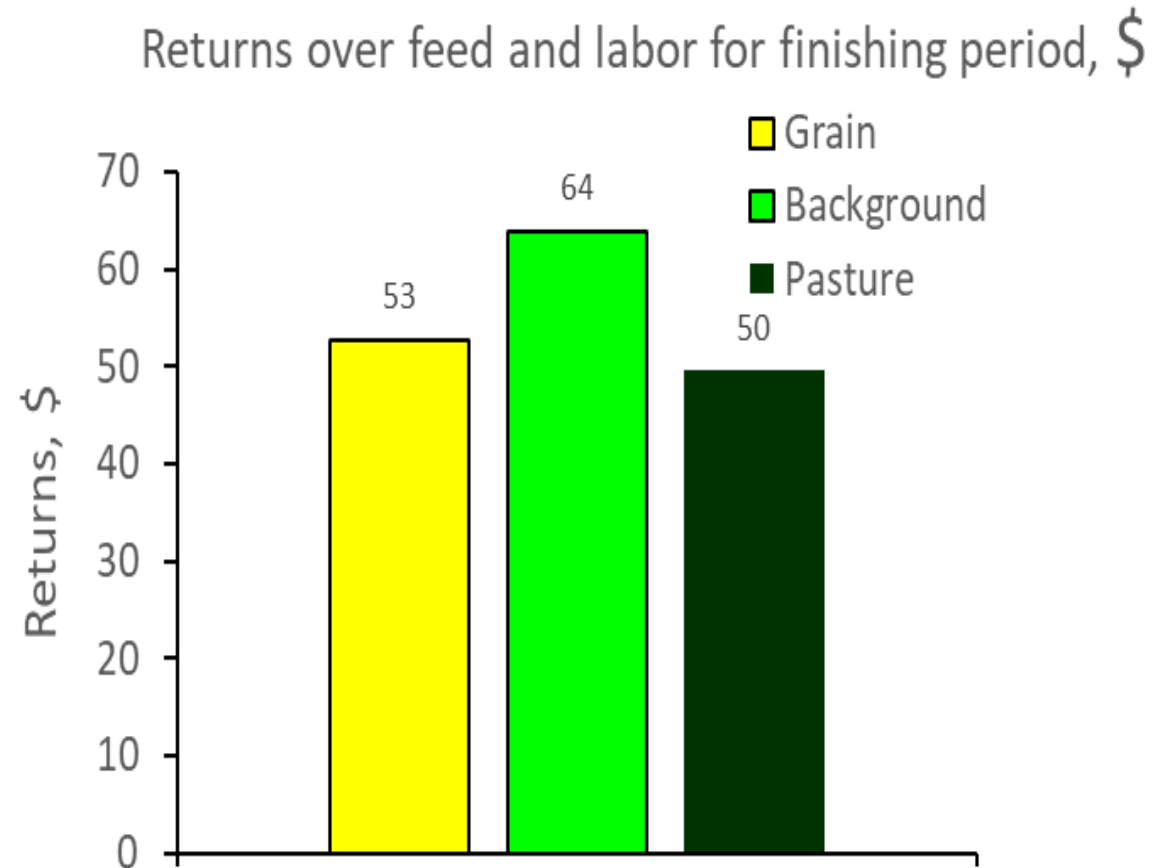
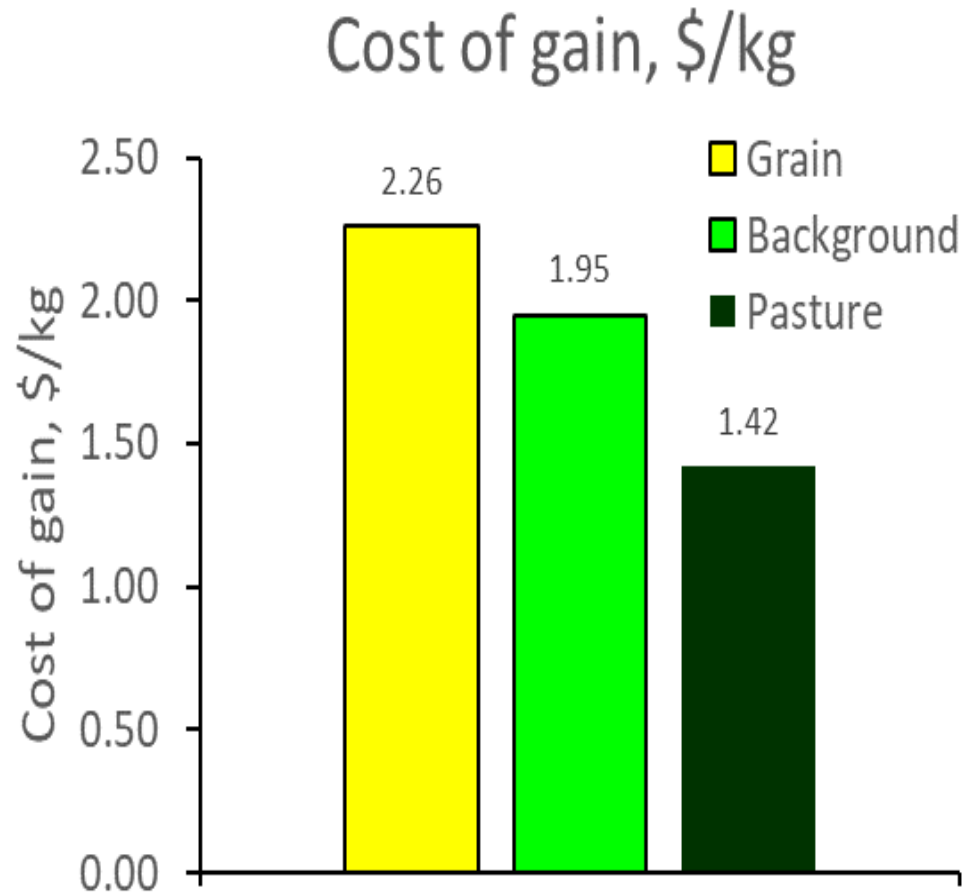
	Treatments				
Meat Trait	GRN	BKG	BRO	MIX	SE
Cooking Loss, %	23.2 <sup>a</sup>	22.0 <sup>ab</sup>	20.8 <sup>b</sup>	22.5 <sup>ab</sup>	0.9
Shear Force, kg	4.24	4.67	4.21	4.08	0.85
Redness, a*	21.6 <sup>b</sup>	23.3 <sup>a</sup>	24.0 <sup>a</sup>	23.1 <sup>a</sup>	1.5
Yellowness, b*	23.4	23.4	23.1	23.3	0.8
Lightness, L*	30.0 <sup>a</sup>	27.3 <sup>b</sup>	25.2 <sup>c</sup>	26.6 <sup>bc</sup>	2.0
Protein, %	23.3 <sup>b</sup>	23.3 <sup>b</sup>	24.0 <sup>a</sup>	24.0 <sup>a</sup>	0.2
Moisture, %	73.1	73.0	72.7	72.7	1.1
Fat, %	4.2	4.2	3.8	4.1	0.5
Collagen, %	2.0	2.0	2.2	2.1	0.5
pH <sup>3</sup>	5.64	5.68	5.68	5.67	0.02

# Sensory Evaluation

## The effect of dietary treatment<sup>1</sup> on consumer palatability traits of lamb loin chops

	Treatments				
Sensory Traits <sup>3</sup>	GRN	BKG	BRO	MIX	SE
Liking	57.2	58.4	64.4	60.9	2.6
Flavor	52.1 <sup>b</sup>	55.7 <sup>ab</sup>	60.7 <sup>a</sup>	57.7 <sup>ab</sup>	2.8
Juiciness	50.4 <sup>b</sup>	51.4 <sup>b</sup>	60.4 <sup>a</sup>	49.5 <sup>b</sup>	2.7
Tenderness	56.4	54.0	63.2	57.3	2.9
Acceptability, % <sup>4</sup>	76.2	69.5	83.8	76.2	4.1

# Economics of Lamb Finishing Systems



Assumptions: \$5.6/kg (Canadian \$ equivalent) liveweight market price, \$253 per ha crop cost, 10 kg DM forage allowance/100 kg BW, \$3.8 yardage for background and grain, \$1.27 for pasture over the entire rearing period.



# Summary

- Lambs on grain diets grew faster and had greater carcass 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 had acceptable fatness for the US traditional market
- 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  $\approx 25\%$  greater for background lambs at current prices.



# Thank you

## **MSU:**

- *Project leaders:* Kim Cassida and Richard Ehrhardt
- *Project collaborators:* Erin Recktenwald, Jeannine Schwehofer, Andrea Garmyn
- *Technical staff:* Barbara Makela and Joe Paling
- *Farm and meat lab staff:* Lacey Quail, Tony Boughton, Tristan Foster, Wes Mays, Trenton Cole, and Jennifer Dominquez
- *Students:* Maci Kubiak, Carol Freitas, Danny Schaub, Allison Schafer, Alexis Stachurski, Grace Herkimer

## **Project cooperators:**

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- Doug Brooks, United Producers Incorporated
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