Influence of Breed and Age on Lamb Performance and Meat Quality

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How is lamb quality defined?

- The ALB lamb quality audit asked lamb purchasers to rank 7 quality attributes (Hoffman et al., 2016).
- Overwhelmingly, respondents most often ranked "Eating Satisfaction" as being most associated with lamb quality.

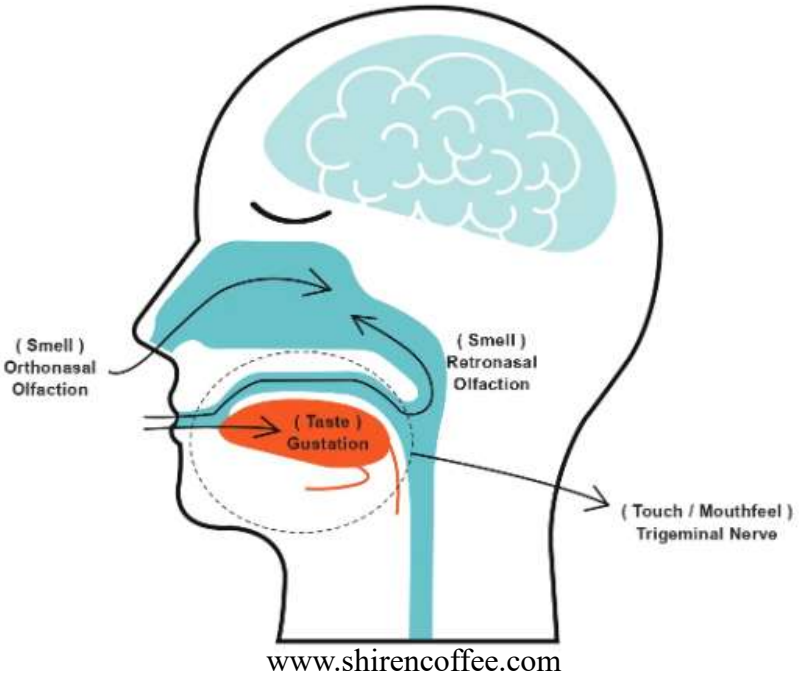
Quality attribute	Shares of preference (%)
Eating satisfaction	38.9
Origin	17.2
Raising practice	13.5
Product appearance	10.5
Weight/size	8.5
Nutrition	7.1
Product convenience	4.2

Eating satisfaction was most often defined as lamb flavor/taste (75.8%)

Inconsistency of lamb flavor is a threat to domestic lamb consumption.

What is lamb flavor?

- Several compounds which accumulate in fat have been identified as contributing to the flavor of sheep meat.
  - Branched chain fatty acids (BCFA) characterize *mutton* flavor (Wong et al., 1975) and typically increase with age (Young et al., 2010).
  - Skatole characterizes *pastoral* flavor (Young et al., 1997).
  - At high concentrations, both classes of compounds can lead to negative consumer eating experience.



Flavor perception is a combination of taste, smell, and mouthfeel.

Factors affecting lamb flavor

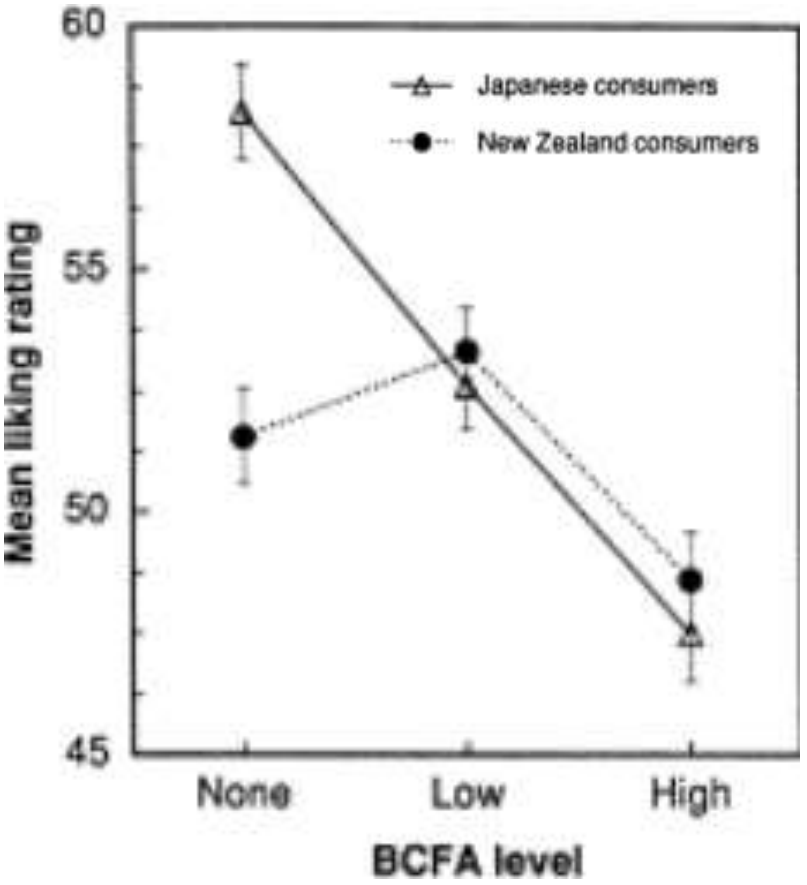
- Many "internet experts" claim differences in breed type on lamb flavor attributes.
  - "Hair sheep do not produce lanolin, lanolin has a foul odor, therefore meat from hair sheep has a milder flavor than meat from wool producing sheep."
- There are *many confounding* factors that can influence lamb flavor when comparing "my" lamb to "your" (industry) lamb.

Pre-harvest:

Nutrition
Stress (transport, health)
Uniformity (age, weight, finish)
Genetics

Post-harvest:

Storage (duration, fresh vs. frozen)
Muscle group (cut)
Cooking method
Consumer preference**



Prescott et al., 2001

Breed effects on lamb flavor

Study/Country	Breeds	Results
Lloyd (1980)/USA	Targhee, Suffolk x Targhee	S x T more desirable (chops)
Crouse (1981)/USA	Suffolk, Rambouillet	No flavor difference (ground)
Ockerman (1982)/USA	Barbados Blackbelly, St. Croix, Florida Native, crossbred	No flavor difference (chops, shoulder)
Little (1984)/Canada	Suffolk, Finnsheep, crosses	No flavor difference (loin)

No consistent differences among breeds.
Caveats: smaller experiments, lambs occasionally sourced from multiple locations with different backgrounds.

- Shackelford et al. (2012): carcasses from 804 contemporary lambs (7.2 mo) from 10 sire breeds reared at USMARC.
- Sire breed differences were observed for carcass characteristics and some eating quality traits (chops).

Sire breed	HCW, kg	LEA, cm^2	BF, mm	Tenderness	Lamb ID
Finn.	28.2^{f}	14.7^{c}	$6.6^{c,d,e}$	5.98^{a}	$4.69^{a,b}$
Dorp.	$32.3^{a,b}$	18.3^{a}	8.8^{a}	$5.75^{a,b,c}$	$4.66^{a,b}$
W. Dorp.	33.4^{a}	18.2^{a}	$8.3^{a,b}$	$5.63^{b,c}$	$4.70^{a,b}$
Kat.	$30.5^{c,d,e}$	16.3^{b}	$7.6^{a,b,c}$	$5.83^{a,b}$	4.80^{a}
Ramb.	29.7^{e}	16.3^{b}	$6.2^{d,e}$	$5.64^{b,c}$	4.62^{b}
Suff.	33.8^{a}	18.2^{a}	$6.4^{d,e}$	5.46^{c}	4.55^{b}

Clear differences among sire breeds in carcass traits. Minor differences in eating quality (1 – 8 scale).

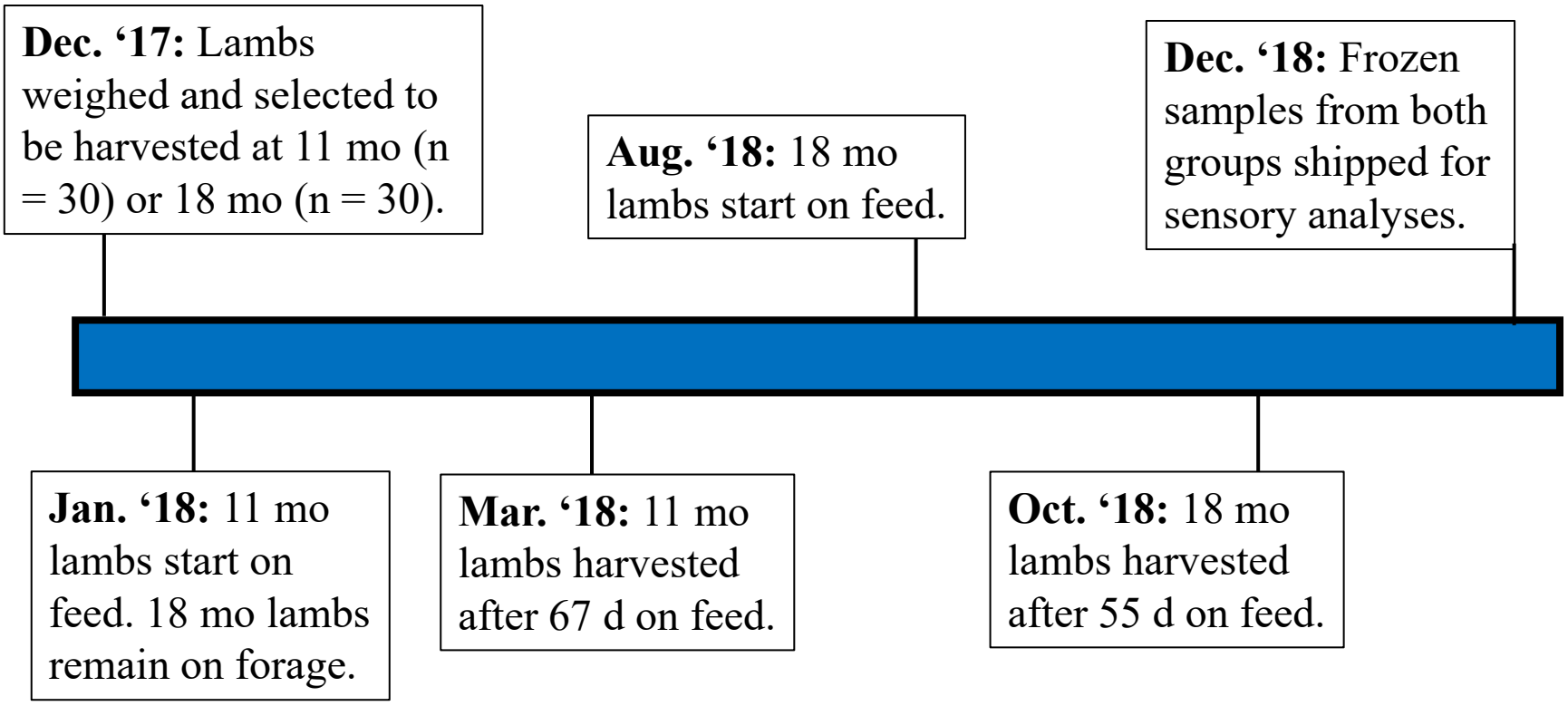
Caveats: Mixture of sensory panels (untrained, trained), very general description of positive and negative attributes.

"Impact of sire breed and harvest age on feedlot performance, carcass characteristics, and meat sensory attributes of wethers"

- **Objectives:** Evaluate the independent and interactive effects of sire breed, harvest age, and cooking temperature on eating quality.
- **Nov 2016:** Mature Rambouillet ewes were randomly assigned to Rambouillet, South African Meat Merino (SAMM), or Suffolk rams.
- **Apr-May 2017:** Lambs born Red Bluff Research Ranch (Norris, MT).
- **Aug 2017:** Lambs weaned (~120 d) transported to Fort Ellis Research Farm (Bozeman, MT).

Study design

- **Aug – Dec ‘17:** Lambs maintained on forage/grass hay.



Murphy et al., unpublished data

Study design

- Harvest age groups were balanced based on pre-trial BW and sire breed, with 10 lambs per sire breed selected in the 11 mo and 18 mo groups (60 total).
- Lambs had *ad libitum* access to a pelleted diet, formulated to be as similar as possible between 11 mo and 18 mo groups.
- Lambs were weighed and feed intake quantified.

FARM TO CAMPUS
MONTANA SOURCED

Carcass data

- Wethers from both groups were harvested the day after finishing their feed intake trial (Pioneer Meats, Big Timber, MT).
- Wethers harvested at 11 mo had lower HCW, higher DP, and lower BF than 18 mo wethers.
- Suffolk sired wethers had higher DP than Rambouillet or SAMM sired wethers.

	Age		Sire breed		
Trait	11 mo	18 mo	Ramb.	SAMM	Suff.
HCW, lb	65.8[b]	79.0[a]	72.9	69.0	75.3
DP, %	50.8[a]	49.5[b]	49.0[b]	49.5[b]	51.9[a]
BF, in	0.13[b]	0.19[a]	0.16	0.16	0.16
LEA, in^2	2.52	2.65	2.53	2.55	2.67

[a,b]Indicates differences between harvest ages or sire breeds.

Murphy et al., unpublished data

Wholesale cuts

- All wholesale cuts were heavier for wethers harvested at 18 mo than 11 mo
- Suffolk sired wethers had heavier shoulder and breast than Rambouillet or SAMM sired wethers.

Murphy et al., unpublished data

	Age		Sire breed		
Trait, lb	11 mo	18 mo	Ramb.	SAMM	Suff.
Loin wt.	5.91[b]	8.02[a]	6.93	6.70	7.28
Leg wt.	18.1[b]	22.6[a]	20.2	19.7	21.1
Rack wt.	7.08[b]	9.34[a]	8.20	7.88	8.56
Shoulder wt.	14.2[b]	15.6[a]	14.5[b]	14.1[b]	16.1[a]
Shank wt.	2.71[b]	3.57[a]	3.07	2.99	3.36
Breast wt.	2.10[b]	2.39[a]	2.18[b]	2.13[b]	2.43[a]

[a,b]Indicates differences between harvest ages or sire breeds.

Sensory panel analyses

- Whole bone-in loin and boneless inside leg roasts were vacuum packaged and frozen until sensory panel and flavor compound analysis at Texas A&M.
- Loin chops were grilled, leg roasts were cooked to final internal temperature (FIT) of either 145° F (medium rare) or 160° F (medium).
- Samples served to an expert five-member panel and 20 different sensory attributes were scored (0 – 15).

Sensory panel positive attributes

Attribute	Definition	Reference
Lamb identity	Lamb flavor intensity	Lamb stock cube (3) Lean ground lamb (6) Lamb broth (7)
Brown	Broiled lamb suet	Lean ground lamb (4) Seared lamb suet (7)
Roasted	Broiled/roasted lamb	Lamb crock pot roast (11)
Connective tissue	Structural component of muscle	Beef brisket steak 158° F (4) Beef tenderloin 158° F (11)
Tenderness	Ease of chewing	Beef eye of round 158° F (4) Beef strip loin 158° F (8) Beef tenderloin 158° F (14)

Sensory panel negative attributes

Attribute	Definition	Reference
Mutton	Older sheep	Fresh sage (2) Mohair, intact mature billy (6) MOA (10)
Lanolin/hair	Oily, lamb off-flavor	Raw wool (4) Bag balm (9)
Bitter	Fundamental caffeine taste	0.2 g 200 mg caffeine pill (2) 200 mg caffeine pill (3.5) ++ (5)
Sour	Citric acid taste	0.02% citric acid (1.5) 0.05% citric acid (3) 0.07% citric acid (5)
Liver	Cooked organ meet flavor	Braunschweiger (10) Broiled beef liver (12)
Green	Sharp, plant matter	Fresh parsley water (9)

Lamb and mutton flavor – Loin

- Lamb identity and mutton flavors in loin chops were impacted by harvest age x sire breed x FIT.
- This complicates interpretation when trying to identify single factors contributing flavor.
  - Ex. Age differences ***depend*** on sire breed and FIT.
  - Ex. Sire breed differences ***depend*** on age and FIT.

Murphy et al., unpublished data

		Sire breed (Harvest age)					
Trait	FIT	R-11	R-18	SM-11	SM-18	SF-11	SF-18
Lamb ID	145°	4.34	4.76	4.15	3.82	4.23	3.84
	160°	4.63	3.81^{y}	4.33	$4.70^{x,y}$	4.10	5.12^{x}
Mutton	145°	0.17^{b}	1.13^{a}	0.20	0.50	0.25	0.25
	160°	$1.33^{a;x}$	0.13^{b}	$0.60^{x,y}$	0.25	0.13^{y}	0.50

^{a,b}Denotes differences between harvest ages within sire breed and FIT.
^{x,y}Denotes differences between sire breeds within harvest age and FIT.

Lamb and mutton flavor – Leg

- Lamb identify flavor in leg roasts was impacted by the harvest age x FIT interaction, but not sire breed.
  - Difference between harvest ages within FIT.
  - Difference between FIT within harvest age.

Murphy et al., unpublished data

		Harvest Age	
Trait	FIT	11 mo	18 mo
Lamb ID	145°	3.85[b]	5.00[a]
	160°	4.41	4.27

[a,b]Denotes differences between harvest ages within FIT.

- Mutton flavor in leg roasts was not impacted by harvest age, sire breed, or FIT.

Harvest age x sire breed

- Several sensory traits of both loin and leg impacted by the harvest age x sire breed interaction.
  - Difference between harvest ages within sire breed.
  - Difference between sire breeds within harvest age.

		Sire breed (Harvest age)					
Trait	Cut	R-11	R-18	SM-11	SM-18	SF-11	SF-18
Brown	Loin	6.67^{b}	$7.81^{a,x}$	7.30	6.50^{y}	6.31^{b}	$7.25^{a;x,y}$
	Leg	$5.53^{b;y}$	7.24^{a}	$6.32^{b;x,y}$	7.53^{a}	7.88^{x}	6.87
Sour	Loin	$3.08^{a;x}$	2.50^{b}	$2.60^{x,y}$	3.00	2.25^{y}	2.50
	Leg	3.32	2.46	2.15^{b}	3.14^{a}	2.24	2.97

^{a,b}Denotes differences between harvest ages within sire breed.
^{x,y}Denotes differences between sire breeds within harvest age.

Murphy et al., unpublished data

Main effects

- Other sensory traits were impacted by just the main effect of harvest age and/or sire breed.

		Age		Sire breed		
Trait	Cut	11 mo	18 mo	R	SM	SF
Roasted	Loin	5.14	5.13	5.42^{a}	5.30^{a,b}	4.69^{b}
Tenderness	Loin	9.27^{b}	11.7^{a}	10.7	10.8	9.94
	Leg	8.81^{b}	11.7^{a}	10.3	9.88	10.5
Connective tissue	Loin	10.9^{b}	12.3^{a}	11.5	12.0	11.4
	Leg	10.4^{b}	12.3^{a}	11.4	11.6	11.1
Liver	Loin	0.40^{b}	1.13^{a}	1.19^{a}	0.83^{a,b}	0.28^{b}
Bitter	Leg	3.14^{b}	3.61^{a}	3.50	3.20	3.42
Green	Leg	1.09	1.17	1.67^{a}	0.95^{b}	0.76^{b}

Murphy et al., unpublished data

Major takeaways

- Breeding a portion of a commercial ewe flock to terminal sires improves lamb growth performance/carcass characteristics.
- Whichever terminal sire breed we use, we can more accurately identify *individual* rams with high expected progeny performance by using NSIP EBV.

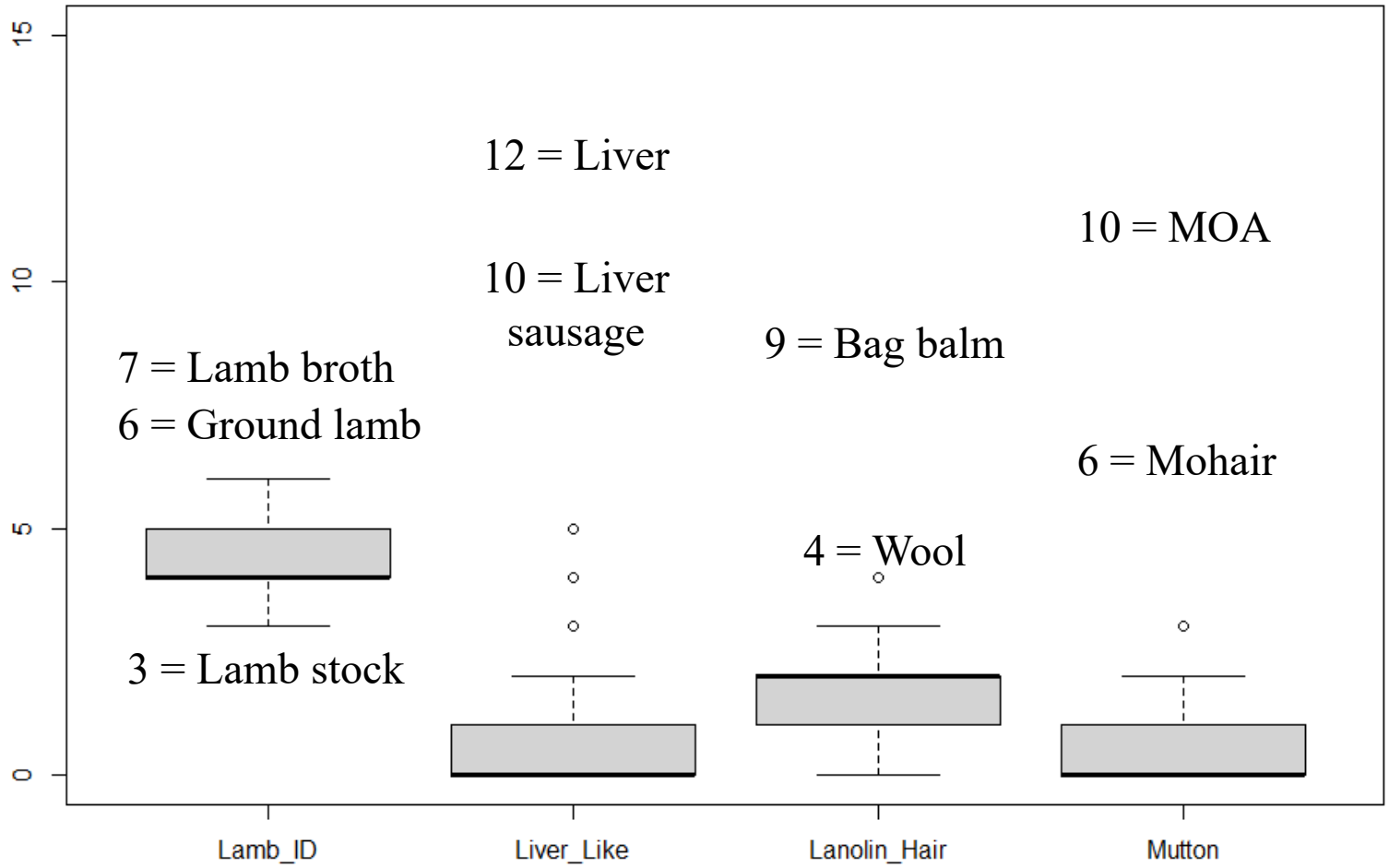
	Sire group		
Trait	**High EMD**	**High Growth**	**Industry**
Finish wt., lbs	143.9	144.7	142.0
HCW, lbs	74.6	73.1	72.3
Rack wt., lbs	8.63	8.42	8.33
Shoulder wt., lbs	18.3	18.1	17.9

"The Mickel Project" A leading edge study (www.nsip.org).

Major takeaways

- Flavor is incredibly complex, and factors contributing to variation are highly nuanced.
  - Lamb ID flavor greater for Suffolk than Rambouillet at 18 mo (not 11 mo), 160° (not 145°), and for loins (not legs).
  - Mutton flavor greater for Rambouillet than Suffolk at 11 mo (not 18 mo), 160° (not 145°), and for loins (not legs).
  - 18 mo had greater tenderness (favorable) but greater liver and bitter flavor (unfavorable).
  - Rambouillet had greater roasted flavor (favorable?) but greater liver and green flavor (unfavorable).
  - 8/20 (loin) and 9/20 (leg) sensory attributes were not impacted by sire breed or harvest age.

Statistical significance vs. Reality



Murphy et al., unpublished data

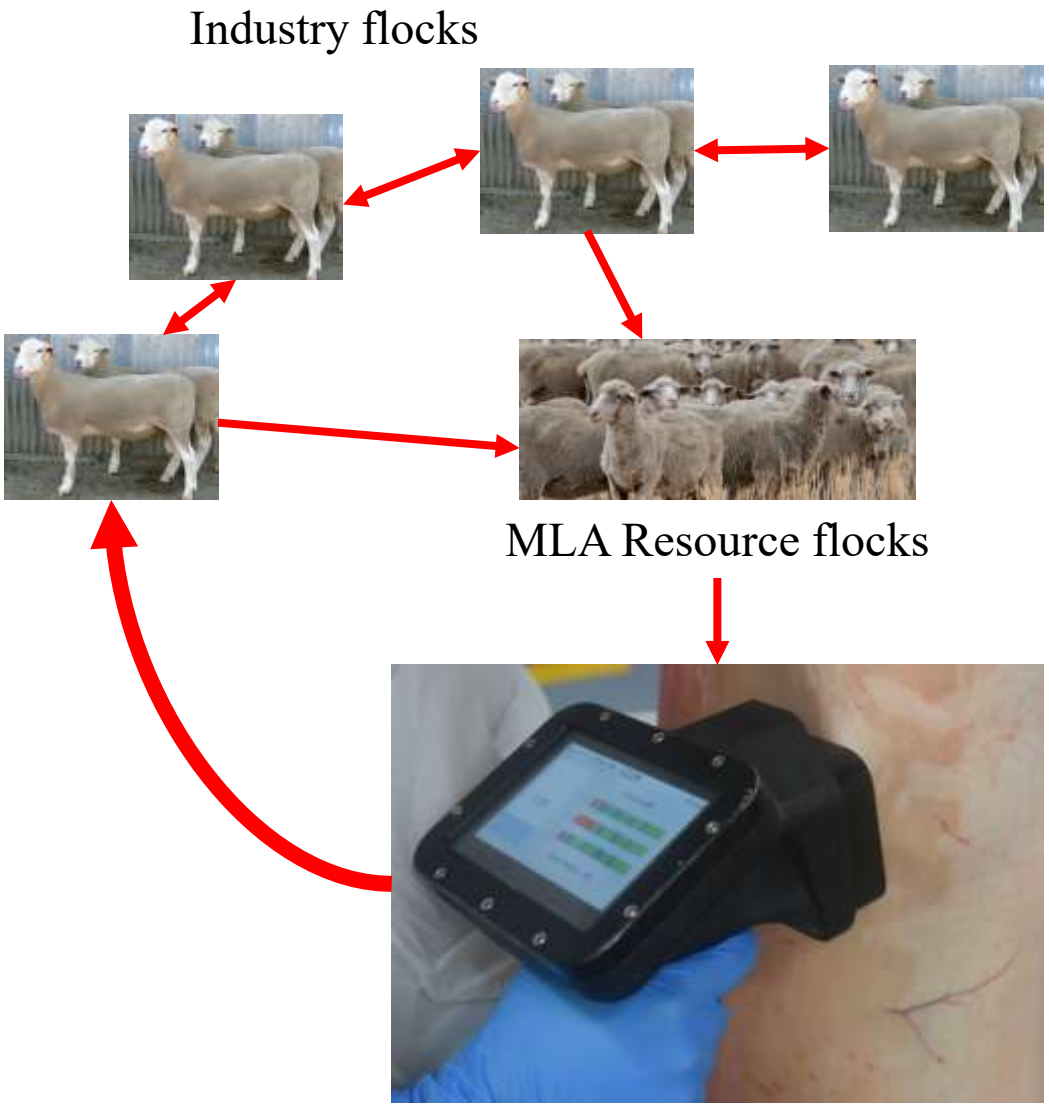
Pragmatism

- Flavor of American lamb is important.
  - Is there incentive to alter it? Are there trade-offs between "better" flavor and what we currently get paid for?
  - Can all the nuanced differences in flavor variation among individual cuts be captured at line speed and make consumer cooking suggestic[illegible]?
- What can we control?
  - High health, low stress
  - Finishing diet
  - Harvest age
  - Appropriate fatness
  - Genetics for eating quality?

LAMBPLAN eating quality index	
Trait	**Emphasis**
Post-wean weight	19%
Eye muscle depth	19%
Dressing percentage	8%
Lean meat yield	5%
IMF	22%
Shear force	24%
Lamb ease	3%

www.sheepgenetics.org.au

How Australia is changing eating quality



Industry flocks
Maintain strong genetic relationships among flocks.
Record standard traits: weight, ultrasound, lamb production, etc.

MLA Resource flocks
Sample industry genetics.
Record standard traits: weight, ultrasound, lamb production, etc.
Record novel traits: carcass traits, ewe health, etc.
Feedback of EBV to industry.

www.meqsolutions.com

ARS genetic reference flocks

- Sample rams from throughout the country and measure difficult or expensive traits in progeny to expand NSIP genetic/genomic evaluation.

Producer-measured traits
Number of lambs born/weaned
Lamb pre- and post-weaning growth
Lamb fecal egg count
Ultrasonic loin muscle and backfat depth

Difficult/expensive traits

Health traits
Mastitis
Immune function
Respiratory disease
Foot rot

Functional traits
Out-of-season/accelerated lambing
Milk/colostrum quality
Longevity
Udder confirmation

Performance traits
Feed efficiency
Lean growth
Primal cut weight
Eating quality

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Questions?

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