Ag Madness: Basic Sheep Nutrition

April 13, 2020

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THE OHIO STATE UNIVERSITY
COLLEGE OF FOOD, AGRICULTURAL, AND ENVIRONMENTAL SCIENCES

It is a pleasure to meet you!

Outline

- Feeding requirements
- Feeding systems
- Grains
- Forages
- Mineral supplementation

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Why feed livestock?

Thoughts from Dr. Francis Fluharty…

- Use the feed that you have?
- More income from grass or grain?
- Use grain more efficiently than grass?
- You like moving fence or cleaning pens?
- You might just like to produce a high demanding food animal protein?
- You enjoy a nice challenge?
- You love what you do!

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Hierarchy of Nutrient Use

- Maintenance
- Development
- Growth
- Lactation
- Reproduction
- Fattening

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Basics of Nutrition

Energy

- "defined as the potential to do work and can be measured only in its transformation from one form to another."
  - Energy demands change based upon: species, age, sex, climate, stage of production, and activity level.
  - Primarily produced from carbohydrates (starches)

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Small Ruminant NRC, 2007

Basics of Nutrition

Protein

- Crude Protein (CP) – amount of protein (N) in a specific feed
- Metabolizable Protein (MP) – true protein = dietary and microbial protein

- Animals eat on a % BW and on a dry matter basis

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Small Ruminant NRC, 2007

Basics of Nutrition

- When feeding ruminant species, we feed microbial populations
- Production of Volatile Fatty Acids (VFA's)
- Grains vs. forages
- Effect of forage to concentrate ratio on rumen Volatile Fatty Acid ratios in feedlot cattle

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Basics of Nutrition

Forage:Concentrate Ratio	Acetate (%)	Propionate (%)	Butyrate (%)
100:0	71.4	16.0	7.9
75:25	68.2	18.1	8.0
50:50	65.3	18.4	10.4
40:60	59.8	25.9	10.2
20:80	53.6	30.6	10.7

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Annison and Armstrong, 1970

Basics of Nutrition

TDN – Total Digestible Nutrients

- Digestible carbohydrates + digestible crude protein + (digestible crude fat x 2.25) = TDN

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Small Ruminant NRC, 2007

Basics of Nutrition

ADF – Acid Detergent Fiber

- Indigestible portions of forages including:
  - **Cellulose-** a structural assembly of glucose particles that make up plant cell walls and are *resistant to breakdown* in the rumen.
  - **Lignin-** similar to cellulose but *cannot be broken down* in the rumen of grazing animals.

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Basics of Nutrition

NDF – Neutral Detergent Fiber

- Structural components of the plant- *hemicellulose, cellulose, and lignin
  - Levels ⬆ as plants mature.
  - As NDF ⬆ feed intake ⬇ .
  - Adds bulk or gut fill.
  - Too much is bad, but too little can also cause issues.

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***Hemicellulose-** structural carbohydrates with less complex bonds than cellulose, which allows for easier breakdown in the rumen.

Finishing Systems

Feedlot

- **Advantages**
  - Animal efficiency
  - Controlled environment
  - Days on feed
- **Disadvantages**
  - Facilities
  - Resources
  - Manure

Pasture

- **Advantages**
  - Utilize land efficiently
  - Niche markets
  - Lean carcasses
- **Disadvantages**
  - Parasites
  - Resources
  - Environment

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Effects of Energy Source in Feedlot Diet

- **3 Treatment Groups:**
  - Treatment #1: Ad lib. whole shelled corn (WSC)
  - Treatment #2: Ad lib. alfalfa pellets (ALF)
  - Treatment #3: Limit-fed whole shelled corn

- **Diets:** #1 → 85% WSC, 15% SUPP
  #2 → 90% ALF, 10% SUPP
  #3 → 80% WSC, 20% SUPP

- **Limit-fed diet fed at 85% of ad lib. diet
  - Adjusted every 2 weeks

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Jaborek et al., 2017

Effects of Energy Source in Feedlot Diet

Growth and performance of finishing lambs

Item	Ad lib. WSC	Ad lib. ALF	Limit-fed WSC
Initial BW (lbs.)	66.4	66.4	66.6
Final BW (lbs.)	137.1	137.6	136.9
ADG (lbs./d)	0.82^{b}	0.64^{a}	0.68^{a}
DMI (lbs./d)	3.2^{b}	4.4^{a}	2.9^{c}
Days on feed	87.5^{a}	110.2^{b}	104.8^{b}
G:F (lbs./lbs.)	0.26^{a}	0.15^{c}	0.24^{b}
Feed $ of gain	0.43^{c}	2.10^{a}	0.49^{b}

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$^{a, b, c}$ means within a row with different superscripts differ ($P < 0.05$)

Jaborek et al., 2017

Effects of Energy Source in Feedlot Diet

Carcass characteristics of feedlot fed lambs

Item	Ad lib. WSC	Ad lib. ALF	Limit-fed WSC
Final BW (lbs.)	134.7	125.7	128.3
HCW (lbs.)	79.1[a]	70.6[b]	75.7[a]
Dressing %	60.6[a]	53.8[b]	58.4[a]
Back fat (in)	0.38[a]	0.20[b]	0.35[a]
LEA (in^2)	2.72	2.49	2.87
BCTRC (%)	44.5	46.5	45.4

[a, b, c] means within a row with different superscripts differ ($P < 0.05$)

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Jaborek et al., 2017

Corn Processing and Fiber Source

2 x 3 factorial design

Main effect #1

- 2 treatment groups
  - Treatment #1: corn type = ground corn
  - Treatment #2: corn type = whole shelled corn

Main effect #2

- 3 treatment groups
  - Treatment #1: fiber type = none
  - Treatment #2: fiber type = soybean hulls
  - Treatment #3: fiber type = peanut hulls

- **All diets remained consistent with the exclusion of the main effects**
  - Type of corn and fiber varied dependent upon treatment

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Hejazi et al., 1999

Corn Processing and Fiber Source

Overall lamb performance (growing and finishing phases)

Item	GC	WSC
Initial wt. (lbs.)	53.4	53.4
DMI (lbs./day)	2.5	2.5
ADG (lbs./day)	0.69[a]	0.72[b]
G:F (lbs./lbs.)	0.27	0.28
Days on feed	77.4	75.1
Final wt. (lbs.)	107.4	107.6

[a, b] means within a row with different superscripts differ for corn type ($P < 0.05$)

[c, d] means within a row with different superscripts differ for fiber type ($P < 0.05$)

Hejazi et al., 1999

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On to you Christine!

Forages

Perennial Forages:

Can sheep be maintained on grass pasture alone?

- Depends!
  - Protein content (> 7% CP)
  - Energy content (adequate TDN levels)
  - Forage maturity

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Forages

- **Prefer a diversity of species**
  - Allows for preferential grazing
  - Sheep prefer short, tender forages (selective grazers)
  - Documentable benefit of having > 3 forage species in a pasture from both an animal and pasture productivity standpoint is minimal.

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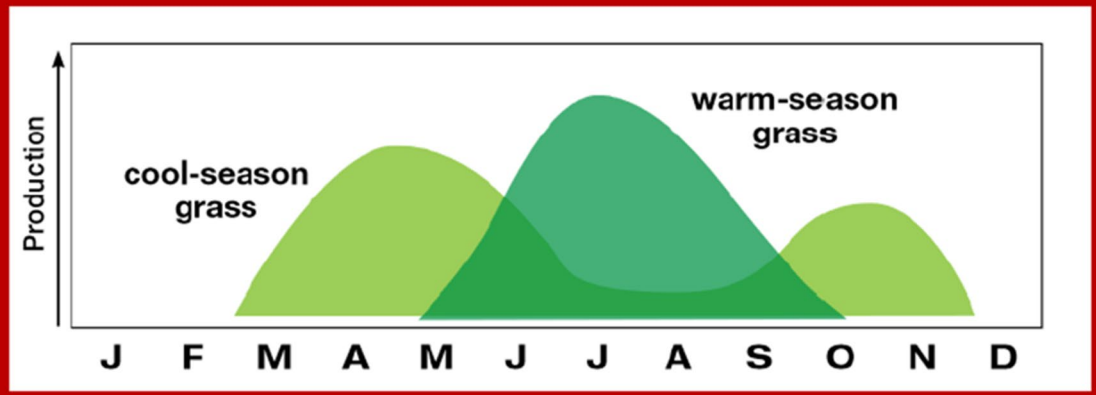
Forage Management

C3 – cool season forages (temperate)

- Favors cool, wet conditions
- Ex. Tall fescue, orchardgrass, clovers, ect.
- Optimum temperature ~ 65ºF - 75ºF
- Does not contain Kranz anatomy

C4 – warm season forages (tropical)

- Favors hot, dry conditions
- Ex. Native forages, bermudagrass, corn
- Optimum temperature ~ 90 ºF - 100ºF
- Efficient at photosynthesis



Growth Curve Model of Cool and Warm Season Grasses from UT Ext. Pub. SP731-A by Keyser, 2012.

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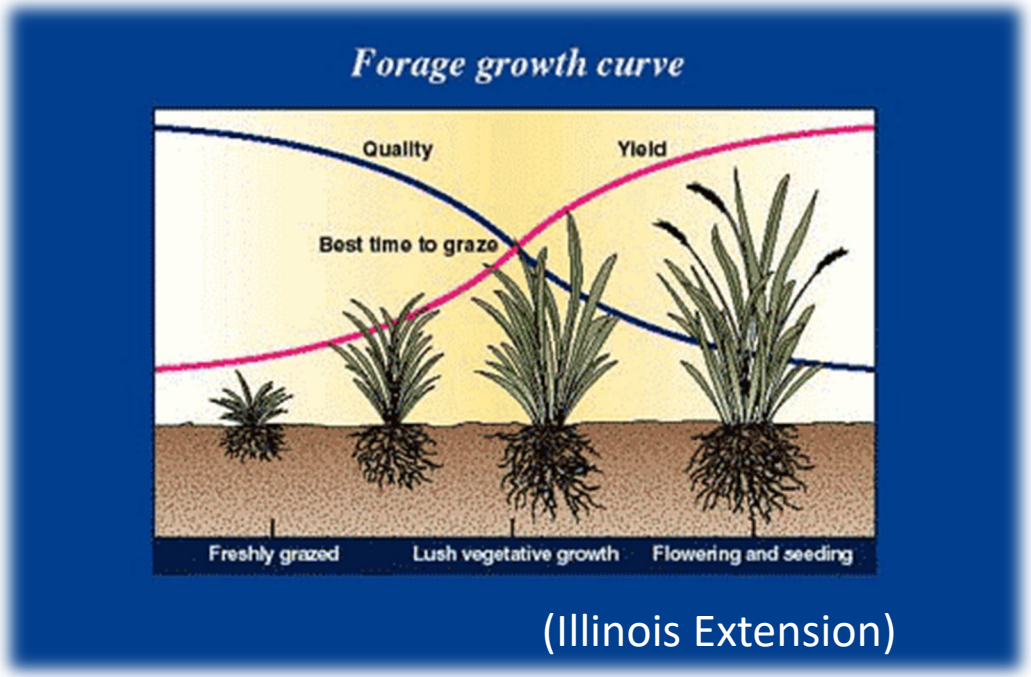
Forage Management

- **Best quality does not maximize yield.**
- **Maximum yield does not maximize quality.**
- **What is more important?**
  - Quality or Yield?
  - What good is a plethora of poor-quality forage?
- **Manage for both quality and quantity.**



(Illinois Extension)

Find Balance

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Forage Management

With Maturity:

Protein ↓

Fiber ↑

Digestibility ↓

Grass Quality by Maturity

Stage	CP	ADF	NDF	RFV
Vegetative	18	33	<55	113
Early heading	16	36	58	106
Head (milk-dough)	11	38	63	91
Head (dough)	9	44	64	81
Mature	<8	>46	>65	<73

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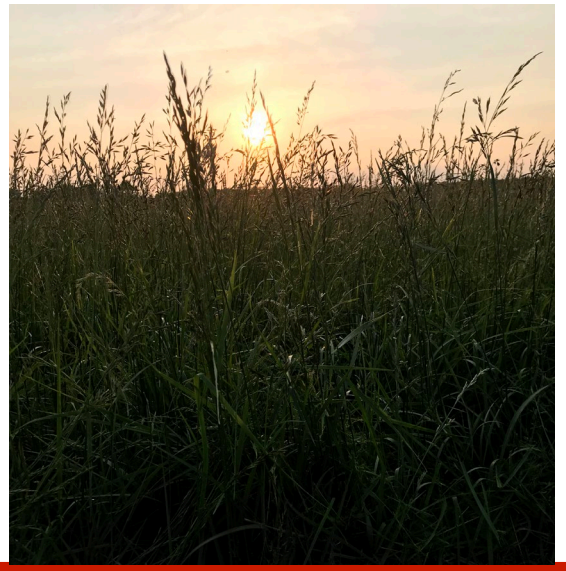
Forage Management

What affects dry matter intake of forages?

- Forage palatability and digestibility
  - Maturity → increased lignin concentration
  - Neutral Detergent Fiber (NDF)
  - Plant structure (C3 vs. C4)



Akin, 1989

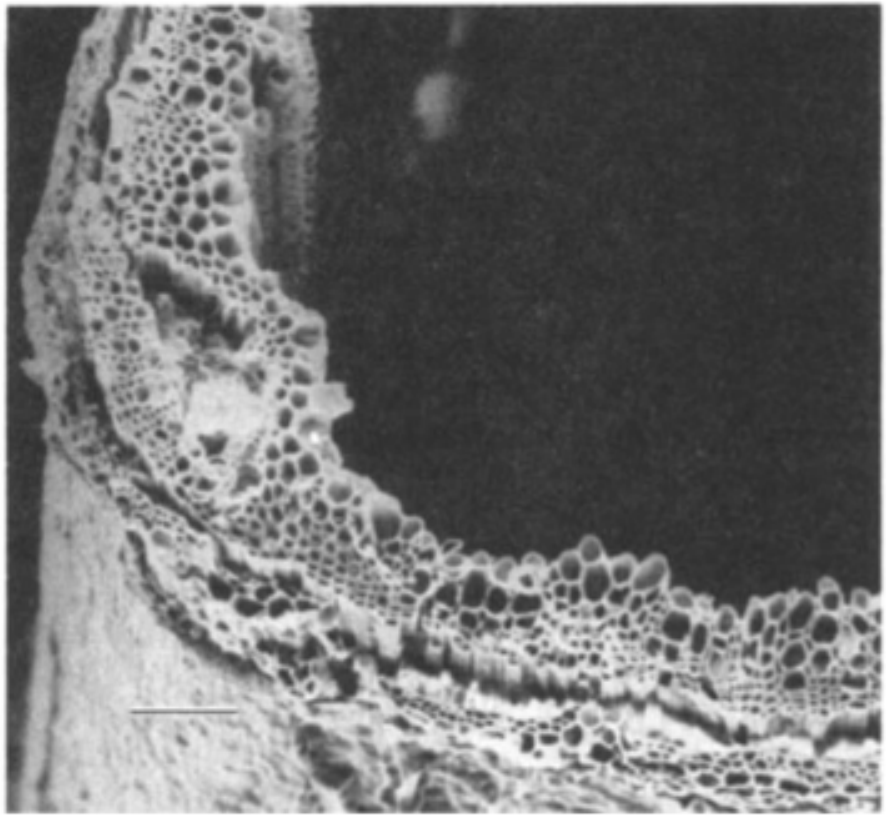
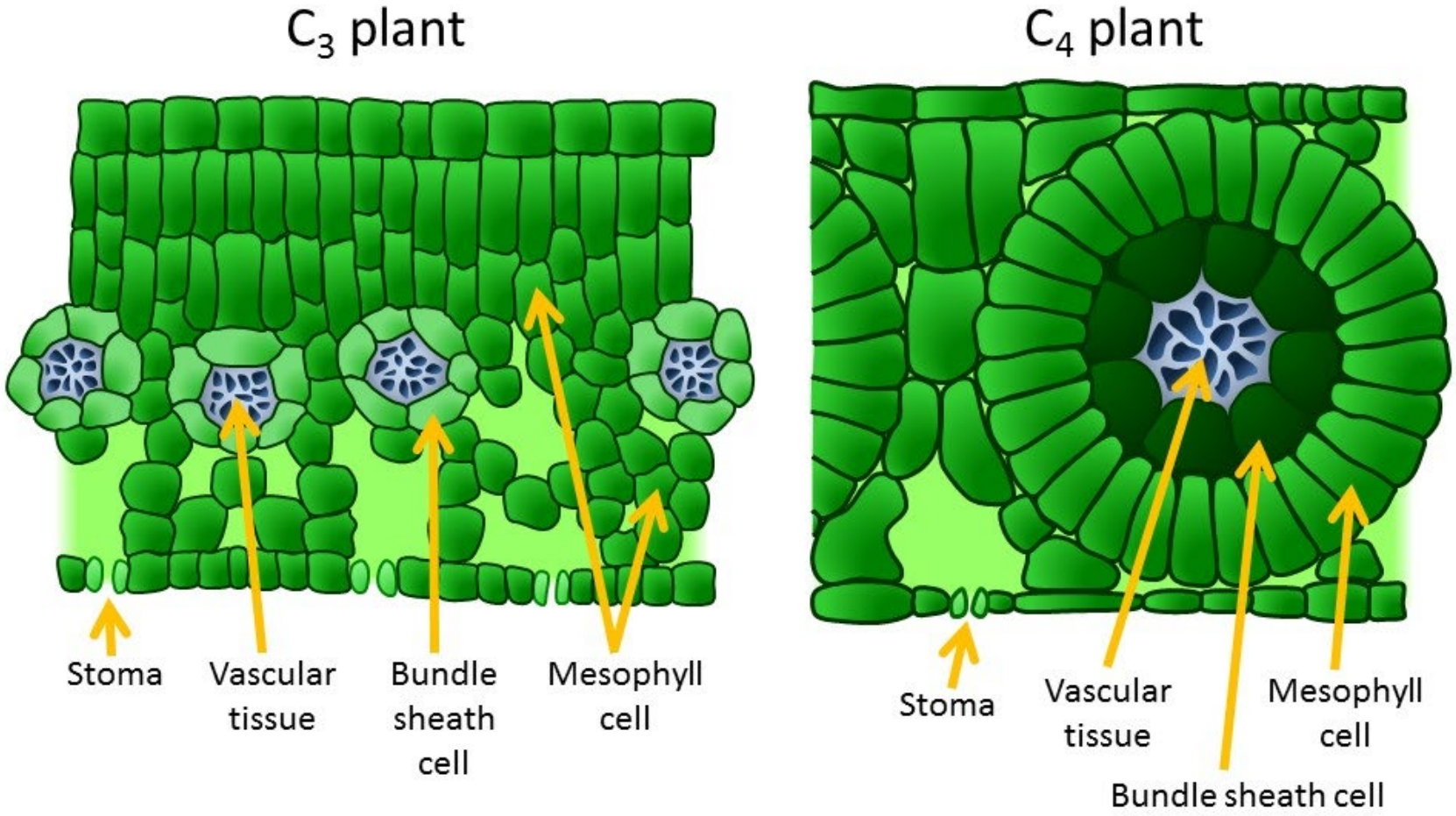


Fig. 4. Scanning electron micrograph of alfalfa stem incubated 48 h with rumen fluid. The residue consists of a ring of lignified bundle and interbundular cells. Parenchyma in the stem center is totally degraded. Bar = 100 μm.

Forage Management

Plant structures

- Epidermis
- Mesophyll
- Schlerenchyma
- Vascular bundles



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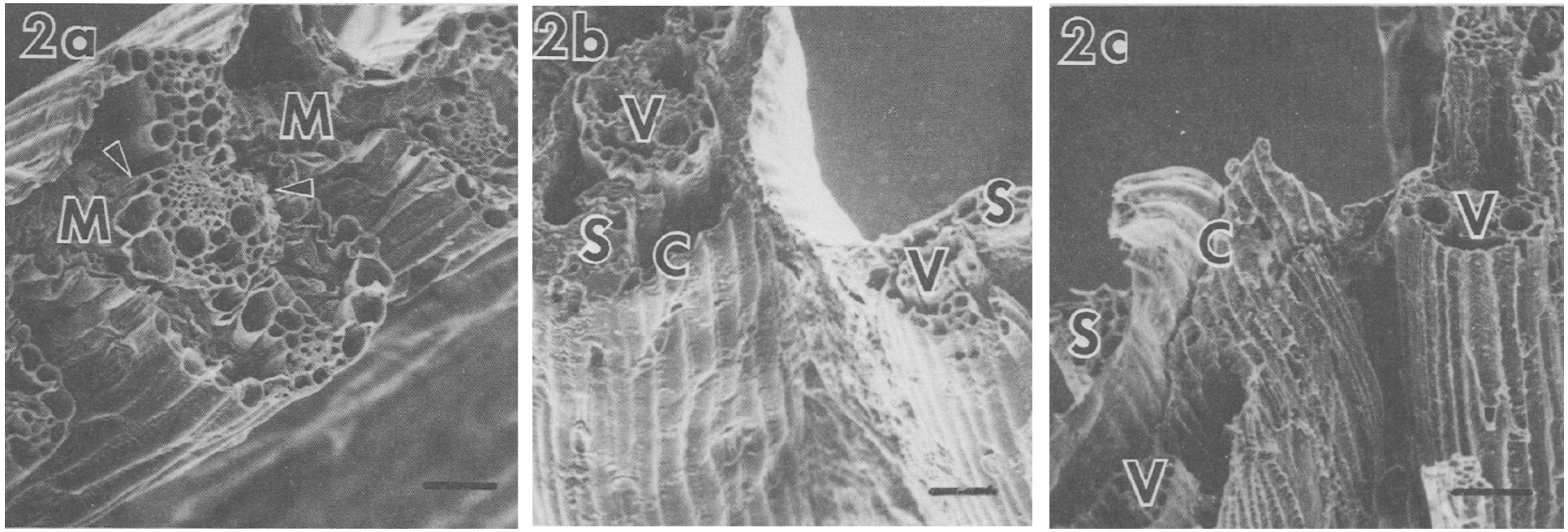
Forage Management

Leaf tissue digestibility – Tall Fescue (C3)

*Forages digest from the inside out!

Akin, 1979



Control

12 hr incubation with rumen fluid

72 hr incubation with rumen fluid

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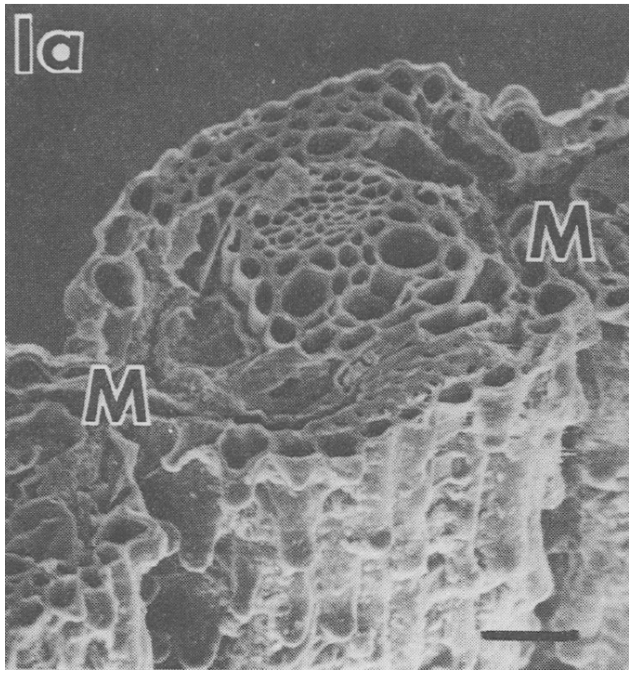
Forage management

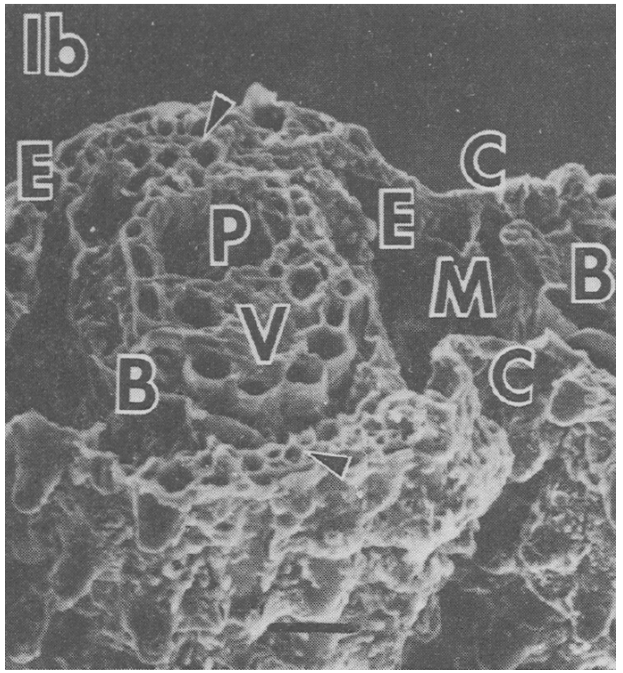
Leaf tissue digestibility – Bermudagrass (C4)

*Forages digest from the inside out!

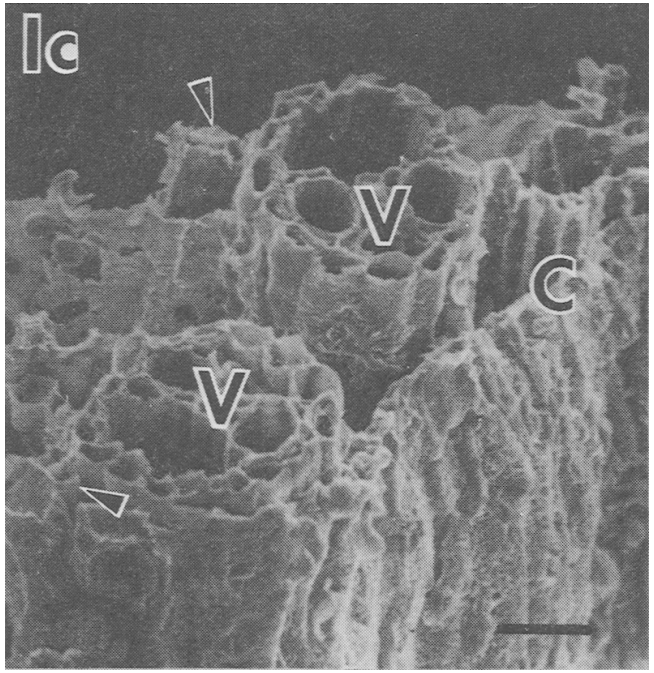
Akin, 1979



Control



12 hr incubation
with rumen fluid



72 hr incubation
with rumen fluid

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Forage Processing

Environmental Conditions
(In order of importance)

- Sunshine (radiant energy)
- Relative Humidity
- Air temperature
- Wind
- Soil moisture

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Forage Processing

Management Factors Affecting Drying Rate

- Cut early to maximize exposure to sun
- Mechanically condition all crops
- Spread in wide swaths
- Rake when crop is 50-60% DM
- Consider chemical conditioning

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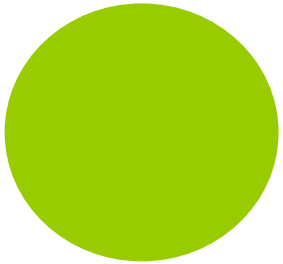
Forage Processing

Bale at Proper Dry Matter

Small rectangular bales 20% moisture



Large round bales 18% moisture

Large rectangular bales 16% moisture

Too wet = spoilage

Too dry = excessive shatter losses

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Forages – Wet Wrapped / Baleage

- **Ideal at 45-60% moisture**
- Dense bales critical
- Wrap at least six times
- Wrap as soon as possible, same day
- When you feed, try to provide amount they will consume quickly

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Back to you Brady!

Forage Nutrient Analysis Example #1

Date Reported: 07/12/2019

O.S.U. Extension-Fairfield Co.
831 College Ave., Suite D
Lancaster, OH 43130-1081

Lab Number: 19-768
SAMPLE I.D.: Mixed Hay
Mixed First Cut

Item	Units	As Sampled Basis	Dry Matter Basis
Moisture	%	10.64	
Dry Matter	%	89.36	
Crude Protein	%	6.12	6.85
Available Protein	%		
Adjusted Crude Protein	%		
A.D.F. Protein	%		
N.D.F. Protein	%		
Soluble Protein	%		
Protein Solubility	%		
Lignin	%		
Acid Detergent Fiber	%	46.14	51.63
Neutral Detergent Fiber	%	58.54	65.51
NFC (Non-Fiber Carbohydrate)	%		
Sugar	%		
Starch	%		
NSC = Starch + Sugar	%		
Crude Fat	%		
TDN	%	33.97	38.02
NEl	Mcal/lb.	.329	.368
NEm	Mcal/lb.	.214	.240
NEg	Mcal/lb.	.002	.002

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Forage Nutrient Analysis Example #2

1 Brassica 11-8-17 B1

Dry Matter 13.48%
Moisture 86.52%

Description (%DM unless specified)	Dry Matter Basis	Grasses 60 dy Avg	4 yr Avg
Crude Protein	**23.02**	12.39	13.70
ADF	**24.77**	38.67	38.08
aNDF	**32.22**	57.53	56.60
Calcium	**1.29**	0.57	0.63
Phosphorus	**0.46**	0.26	
Magnesium	**0.34**	0.26	
Potassium	**4.42**	1.95	2.41
Sulfur	**0.45**	0.16	0.19
Starch	**4.12**		9.15
NDF Digest.: Traditional=Goering & Van Soest Method, Standardized=Combs-Goeser Method			
Traditional NDFD 48, %NDF	**29.96**	58.62	62.06
Calculations			
TDN 1X	72.78		
NEL 3x, Mcal/lb	0.713		
NEG, Mcal/lb	0.555		
NEM, Mcal/lb	0.842		
RFV	201		100
NFC	29.00		

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Changes in Forage Quality

Summary

Table 1:

Forage type	Collection date	Crude Protein (%)	NDF	TDN (%)
Brassica	11/08/2017	23.02	29.96	72.78
Brassica	12/13/2017	20.50	30.25	70.25
Oats	11/08/2017	25.20	53.99	73.12
Oats	12/13/2017	17.63	44.75	59.40
Stockpiled Fescue	11/08/2017	14.61	57.82	68.64
Stockpiled Fescue	12/13/2017	11.09	51.97	64.34

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Campbell et al., unpublished

Predicted Energy Demands
Maintenance

Table 2: Calculated TDN requirements for a 154 lb. ewe using forage TDN values from 11/08/2017

Animal Class (Ewe – 154 lbs.)	Estimated Intake* (lbs./d)	Required TDN (lbs./d)	Brassica	Oats	Stockpiled Pasture
Maintenance	2.59	1.36	1.89	1.89	1.78

** Estimates derived from the Small Ruminant NRC, 2007*

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Predicted Energy Demands
Early Gestation

Table 3: Calculated TDN requirements for a 154 lb. ewe using forage TDN values from 11/08/2017

Animal Class (Ewe – 154 lbs.)	Estimated Intake* (lbs./d)	Required TDN (lbs./d)	Brassica	Oats	Stockpiled Pasture
Early Gestation (single)	3.22	1.72	2.34	2.35	2.21
Early Gestation (twins)	3.71	1.96	2.70	2.71	2.55
Early Gestation (triplets)	4.02	2.13	2.93	2.94	2.76

** Estimates derived from the Small Ruminant NRC, 2007*

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Predicted Energy Demands
Late Gestation

Table 4: Calculated TDN requirements for a 154 lb. ewe using forage TDN values from 11/08/2017

Animal Class (Ewe – 154 lbs.)	Estimated Intake* (lbs./d)	Required TDN (lbs./d)	Brassica	Oats	Stockpiled Pasture
Late Gestation (single)	3.97	2.11	2.89	2.90	2.73
Late Gestation (twins)	4.02	2.66	2.93	2.94	2.76
Late Gestation (triplets)	4.56	3.01	3.32	3.33	3.13

** Estimates derived from the Small Ruminant NRC, 2007*

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Predicted Energy Demands-
November Summary

Table 5: Calculated TDN requirements for a 154 lb. ewe using forage TDN values from 11/08/2017

Animal Class (Ewe – 154 lbs.)	Estimated Intake* (lbs./d)	Required TDN (lbs./d)	Brassica	Oats	Stockpiled Pasture
Maintenance	2.59	1.36	1.89	1.89	1.78
Early Gestation (single)	3.22	1.72	2.34	2.35	2.21
Early Gestation (twins)	3.71	1.96	2.70	2.71	2.55
Early Gestation (triplets)	4.02	2.13	2.93	2.94	2.76
Late Gestation (single)	3.97	2.11	2.89	2.90	2.73
Late Gestation (twins)	4.02	2.66	2.93	2.94	2.76
Late Gestation (triplets)	4.56	3.01	3.32	3.33	3.13

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** Estimates derived from the Small Ruminant NRC, 2007*

Predicted Energy Demands-
December Summary

Table 6: Calculated TDN requirements for a 154 lb. ewe using forage TDN values from 12/13/2017

Animal Class (Ewe – 154 lbs.)	Estimated Intake* (lbs./d)	Required TDN (lbs./d)	Brassica	Oats	Stockpiled Pasture
Maintenance	2.59	1.36	1.82	1.53	1.67
Early Gestation (single)	3.22	1.72	2.26	1.91	2.07
Early Gestation (twins)	3.71	1.96	2.61	2.20	2.39
Early Gestation (triplets)	4.02	2.13	2.82	2.39	2.59
Late Gestation (single)	3.97	2.11	2.79	2.36	2.55
Late Gestation (twins)	4.02	2.66	2.82	2.39	2.59
Late Gestation (triplets)	4.56	3.01	3.20	2.71	2.93

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** Estimates derived from the Small Ruminant NRC, 2007*

Mineral Supplementation

Mineral should ALWAYS be available

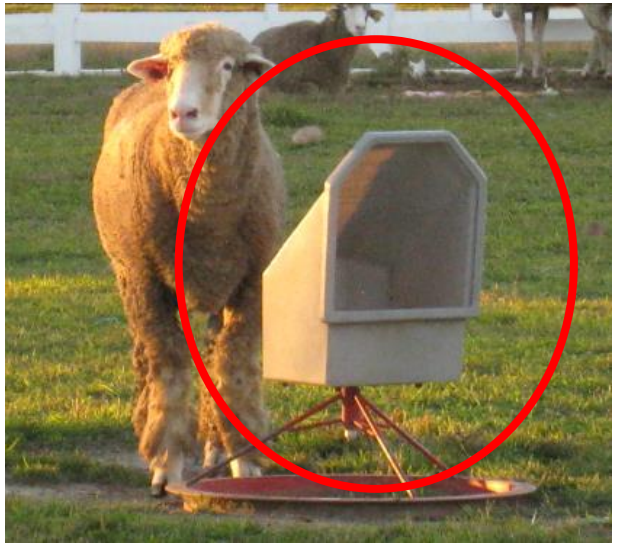
Why?

- Zinc - foot health, eye health, growth, immunity, parasites
- Selenium - muscle development, immunity, growth
- Copper - bone formation, growth, foot health, parasites

Mineral interactions

Mineral bioavailability

How is the mineral being provided?



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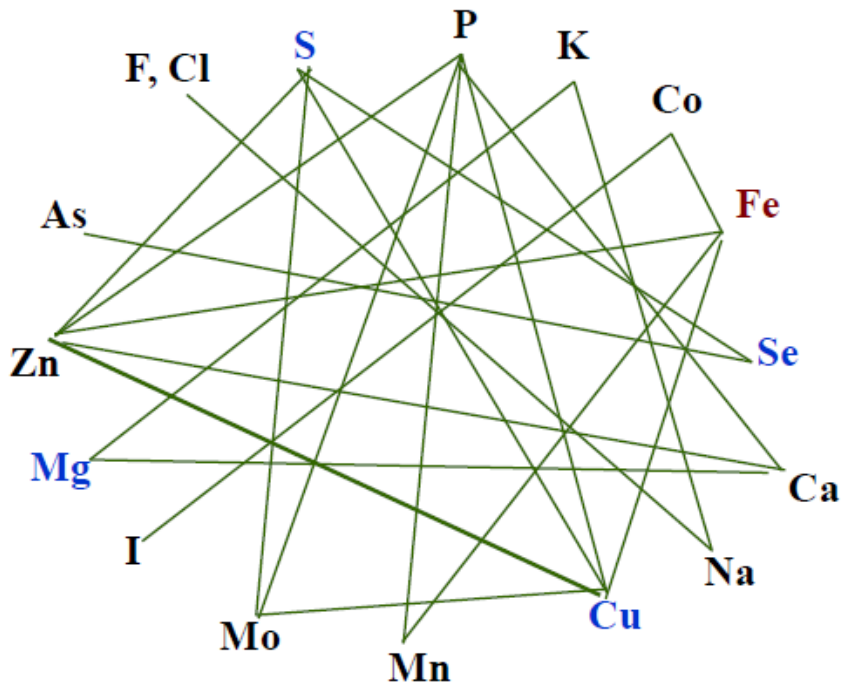
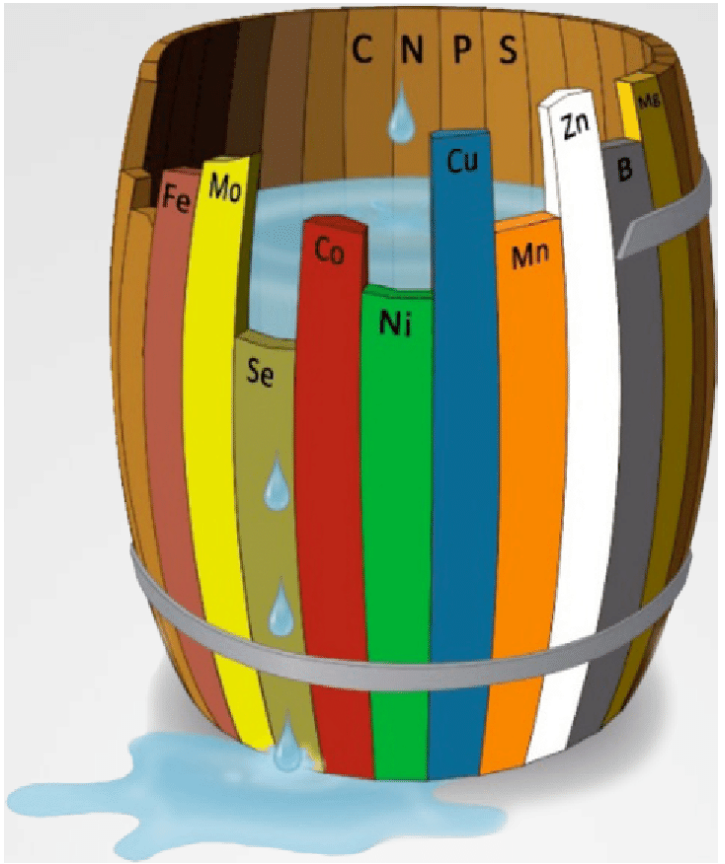
Mineral Supplementation





Liebig's barrel – Liebig's Law of the Minimum

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Mineral Supplementation

Mineral bio-availability:

Relative Bioavailability of Microminerals from Different Sources

Mineral	Sulfate-form	Oxide-form	Carbonate	Chloride-form	Organic-form (complex, chelate)
Copper	100	0	–	105	**130**
Manganese	100	58	28	–	**176**
Zinc	100	–	60	40	**159 to 206**

[1]**Availability relative to that of the sulfate form**. Adapted from Greene, 1995.

Source: http://pubsadmin.caes.uga.edu/files/pdf/B%20895_2.PDF

Mineral Supplementation

Effect of mineral form on lamb ADG during the grazing period

Item	Loose	Block
AVG salt intake (oz./lamb/d)	0.010[a]	0.005[b]

Ragen et al., 2015

Item	Loose Mineral	Block Mineral
Initial BW (lbs.)	52.3	52.3
Final BW (lbs.)	79.4[a]	74.7[b]
Overall ADG (lbs./d)	0.43[a]	0.35[b]

Campbell et al., 2017

[a, b, c] means within a row with different superscripts differ ($P < 0.05$)

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Conclusions

- **In general, lambs fed high concentrate diets perform better when compared to others fed forages**
  - However this is not always the case!
- **The processing of feedstuffs can affect lamb performance and feed digestibility**
- **Grain fed vs. forage fed lambs?**
  - Lean vs. Fat deposition
- **Diet will be dependent upon resource availability, market access, and personal preference**

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