Dietary Supplements: A Necessity or Folly?

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What is a supplement?

- Definition: “something that completes or enhances something else when added to it”
- Additional source of essential or useful nutrients to complement forage diet
- Does forage-based diets need supplements?

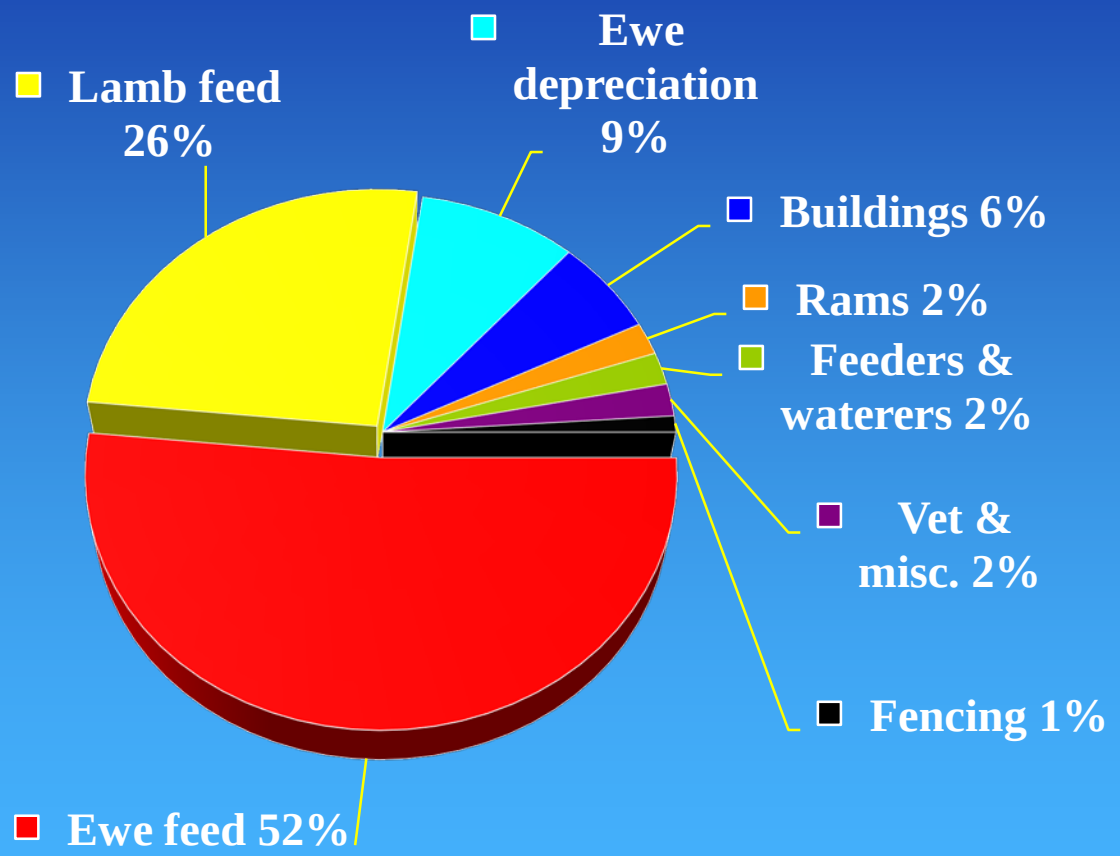
Essential Nutrients:

- Water
- Energy
- Protein
- Fatty acids
- Macrominerals (Ca, P, Mg, Na, K, S)
- Microminerals (Co, Cu, Fe, I, Mn, Se, Zn)
- Vitamins
  - Fat-soluble
  - Water-soluble
- Fiber??

Production Expenses

Nearly 80% of all production expenses are devoted to nutrition.

Small percentage reductions in feed costs can greatly affect profitability.



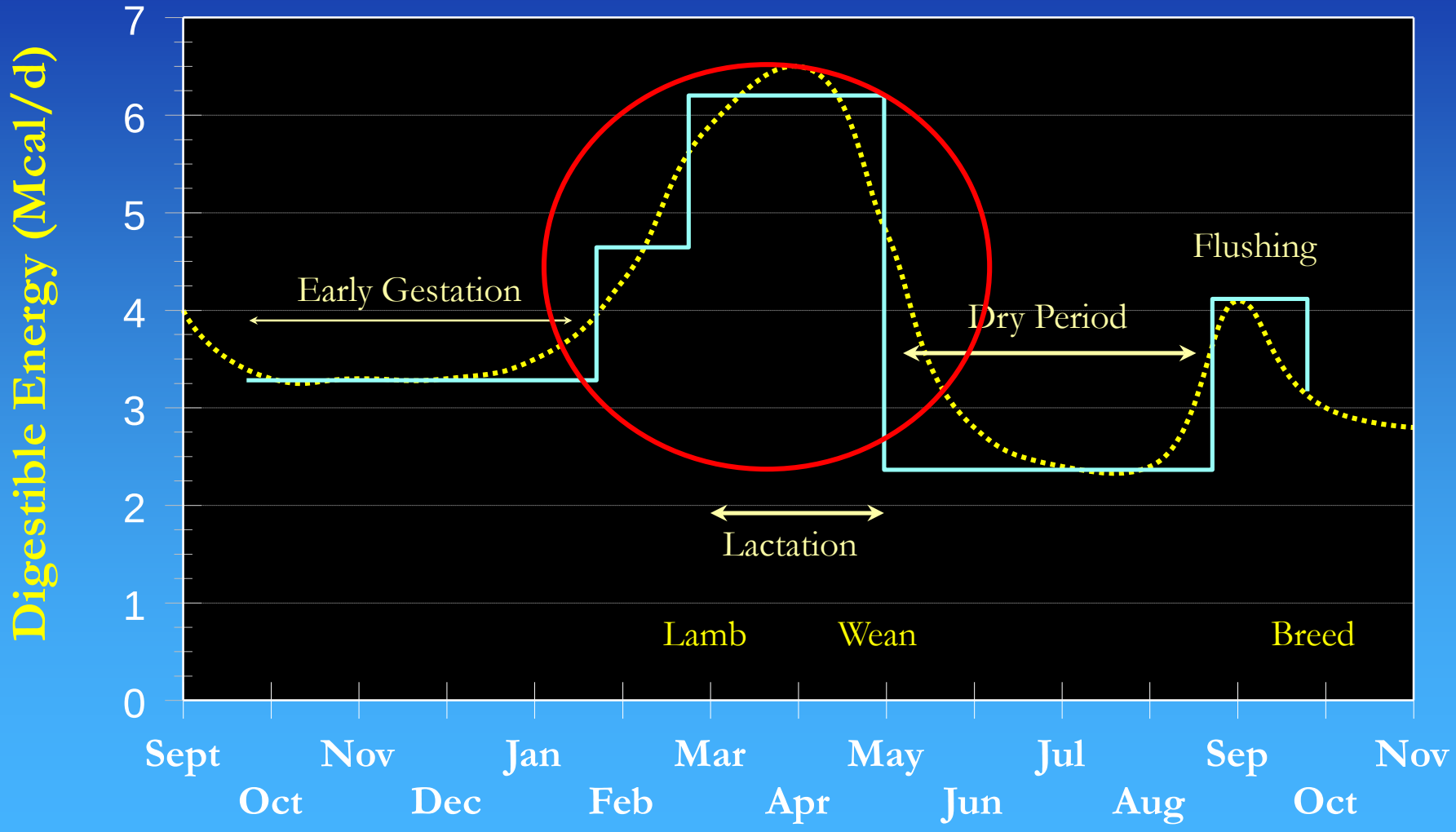
Midwest data, Jordan, U. Minn

Why would a supplement be needed for a forage-based diet?

How does <u>your</u> forage *limit* or *promote* your feeding program?

Photo from Dr. Joe Rook

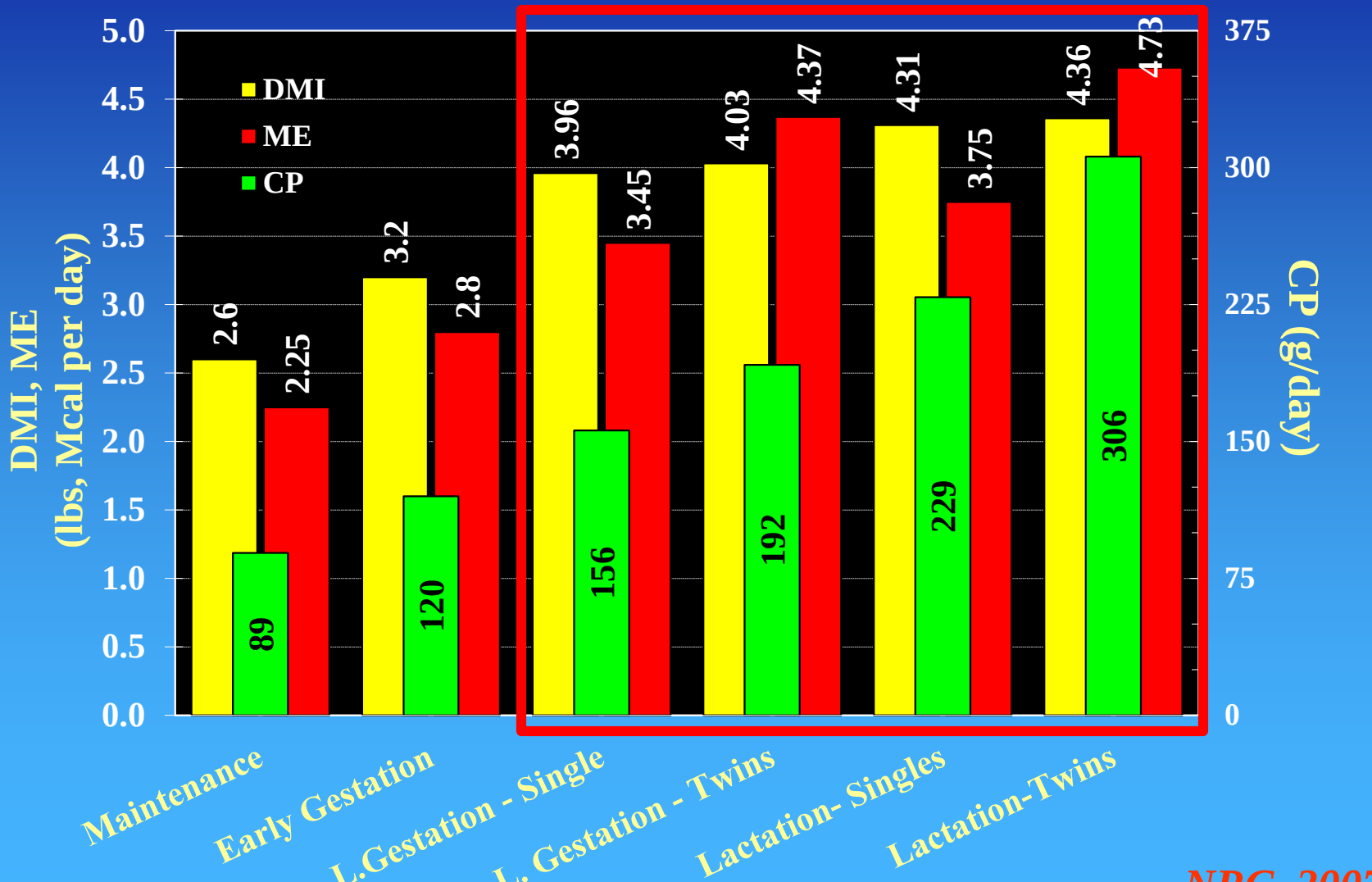
Ewe Production Cycle



NRC, 1985

Ewe Requirements

(154 lb Mature BW)

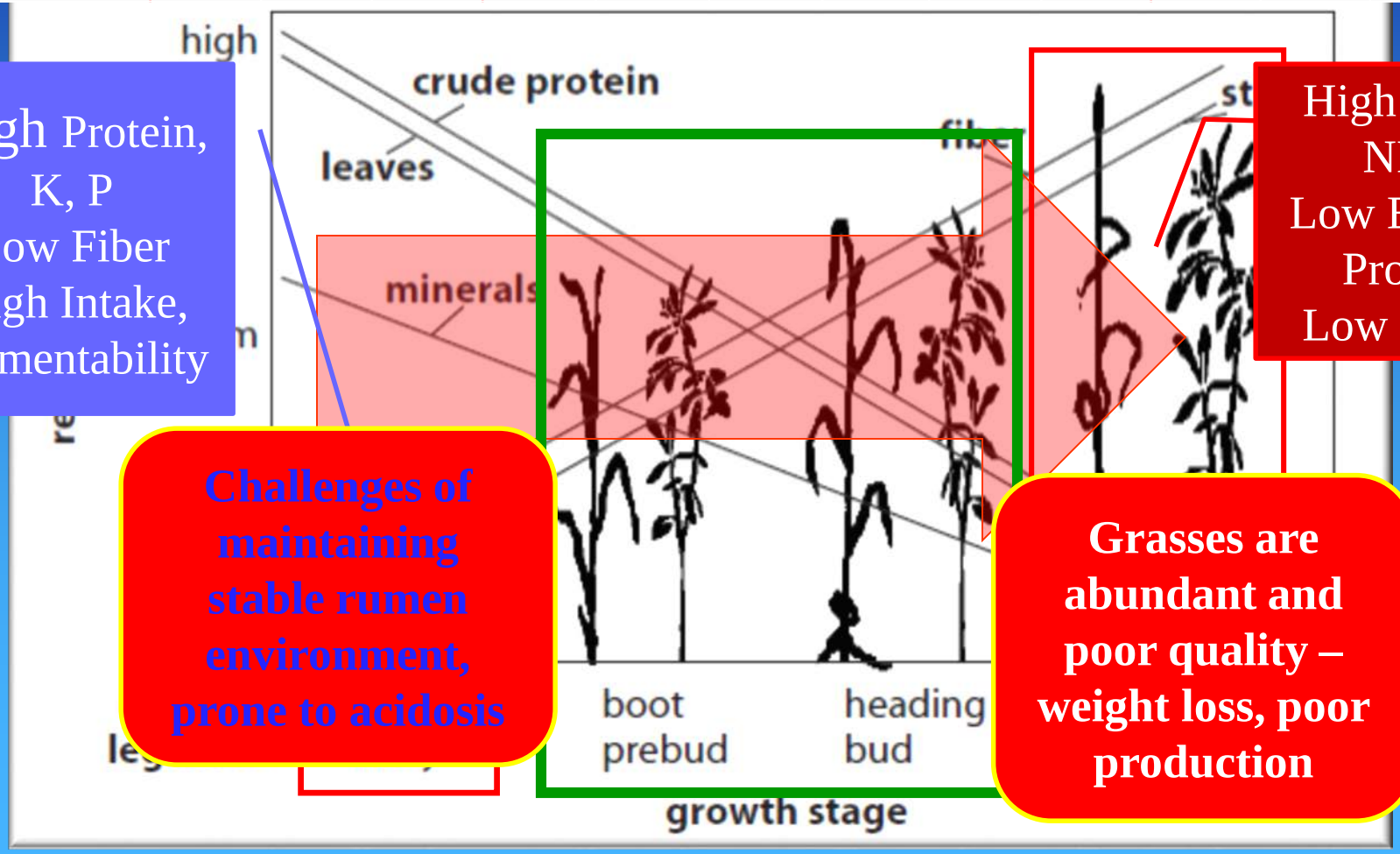


NRC, 2007

Plant Maturity

	TDN%	CP%	NDF%	TDN%	CP%	NDF%	TDN%	CP%	NDF%	TDN%	CP%	NDF%
Alfalfa	> 64	>19	< 40	56-60	17-19	40-46	50-55	13-16	47-51	< 50	<13	> 51
Grass	> 54	>18	< 55	47-54	13-18	55-60	43-46	8-12	61-65	< 41	< 8	> 65

High Protein,
K, P
Low Fiber
High Intake,
Fermentability



High Fiber,
NDF
Low Energy,
Protein
Low Intake

Challenges of maintaining stable rumen environment, prone to acidosis

Grasses are abundant and poor quality – weight loss, poor production

NDF Intake Capacity

Silage 24.8 % DM, 18.8% CP, 48.5% NDF

Pregnancy Week	NDF Intake as % of Body Weight		
	Singles	Twins	Triplets
15	0.83	0.81	0.74
16	0.81	0.73	0.71
17	0.81	0.65	0.68
18	0.74	0.65	0.64
19	0.69	0.62	0.59
20	0.70	0.60	0.55
Mean	0.76	0.68	0.65

Orr et al., Anim Prod 1983;36:21

Effect of Forage NDF

Forage NDF%	Week	NDF Intake as %BW		
		Singles	Twins	Triplets
44.9	18-20	0.83	0.70	0.70
48.5	18-20	0.71	0.62	0.59
48.5	15-17	0.82	0.74	0.71
63.8	15-17	0.78	0.70	0.70

Orr et al., Anim Prod 1983;36:21

Nutrient Intake Comparison

McNeil et al., JAS 1997;75:809

	Low Protein	Mid Protein	High Protein
DMI, kg	1.02	1.16	1.37
% of BW	1.65	1.87	2.21
ME, Mcal/kg	2.7	2.7	2.7
Mcal/day	2.2	2.7	3.3
CP, %	7.9	11.6	15.7
g/day	81	141	215
NDF, %	42.9	41.5	39.3
% of BW	0.71	0.78	0.89
NRC Require.	*1.7 kg DMI*	*3.94 Mcal ME*	*183 g CP*

Adjusted NRC Requirements

Mature ewe, 70 kg, late pregnancy 180-225% lambing rate

	DMI		ME	CP	NDF	Ca	P
Total	4.03 lbs		4.37 Mcal	192 g	560 g	8.8 g	5.3 g
Density	2.6 % BW		1.08 Mcal/lb	10.3%	30.6%	0.48 %	0.29 %
Adjusted Intake Level	lbs	% BW	Mcal/lb	% DM	% DM	% DM	% DM
	2.8	1.8	1.56	15.1	44.0	0.69	0.42
	3.1	2.0	1.41	13.6	39.8	0.63	0.38
	3.4	2.2	1.29	12.4	36.3	0.57	0.34
	3.7	2.4	1.18	11.4	33.3	0.52	0.32

NRC, 2007

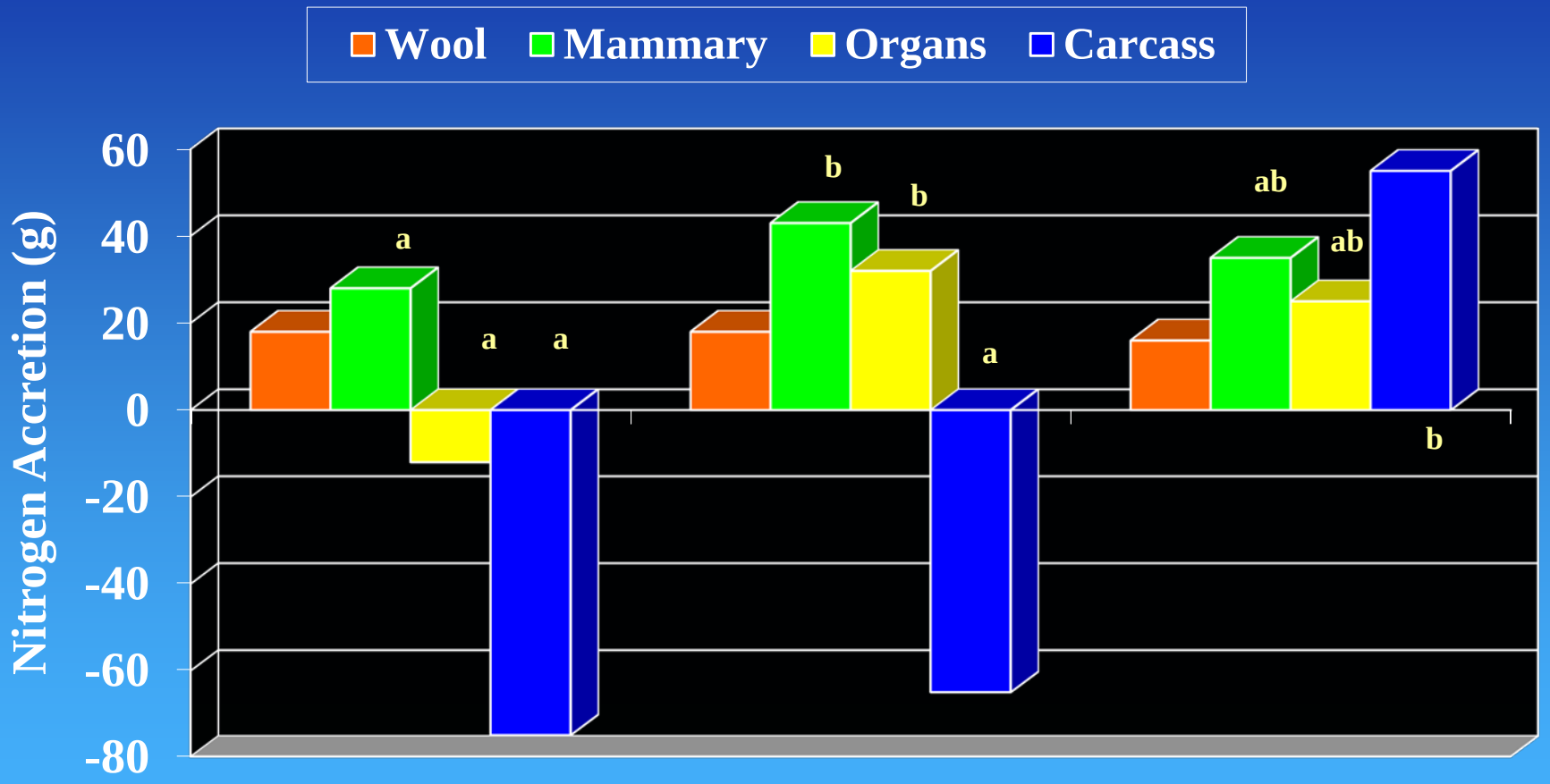
Improper Feeding during Late Pregnancy . . .

- Metabolic disease in ewes
- Poor supply of colostrum
- Poor milk yield
- Small or Large weak neonates
- High postnatal losses

Failing to Prepare. . . .

. . . . Is Preparing to Fail!

Maternal Tissue Nitrogen Partitioning in Pregnant Ewes



	Low CP	Mid CP	High CP
Total Lamb BW	16.5 lb[b]	18.7 lb[a]	19.2 lb[a]

McNeill et al., 1997

Gestation Diet Effects on Colostrum Production

	Low Energy		High Energy	
Mean ME intake (Mcal)	1.94	1.94	3.47	3.47
Mean CP intake (g)	80	128	128	185
Colostrum Production	- - - - kg - - - -			
First 3h after lambing	0.15	0.32	0.38	0.64
First 24h after lambing	1.02	1.58	1.89	2.1

Robinson, 1987

Nutrition and Parasite Control

- Improving protein and not energy status in late pregnancy improved GI immunity to parasites *(Jones et al., Intl J Parasit 2011)*
- Improved body protein status and increased dietary protein supply reduced fecal egg counts and improved immune status *(Houdijik et al., Vet Parasit 2000; Houdijk et al., Parasitology 2001)*
  - Diets provided either 85% or 130% of MP requirements

Effect of Protein on FEC

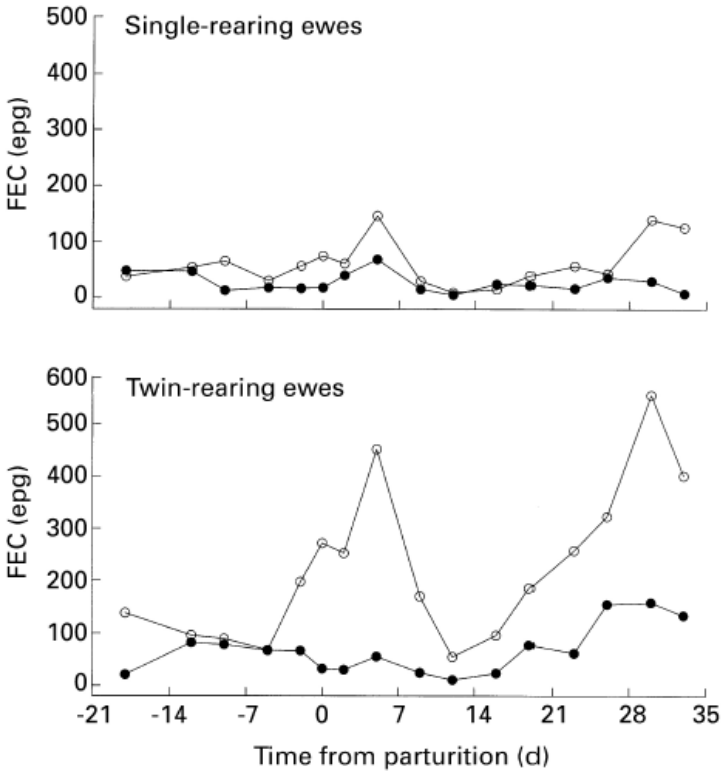


Fig. 1. Backtransformed mean faecal egg count (FEC, expressed as no. of nematode eggs per g faeces (epg)) of single- or twin-rearing ewes fed *ad libitum* foods that were calculated to provide either scarce (○) or adequate (●) amount of metabolisable protein. The ewes were infected with *Teladorsagia circumcincta* at a rate of 10 000 3rd stage infective larvae per d for 3 d per week from day –49 onwards. (Redrawn from Houdijk *et al.* 2001*a*.)

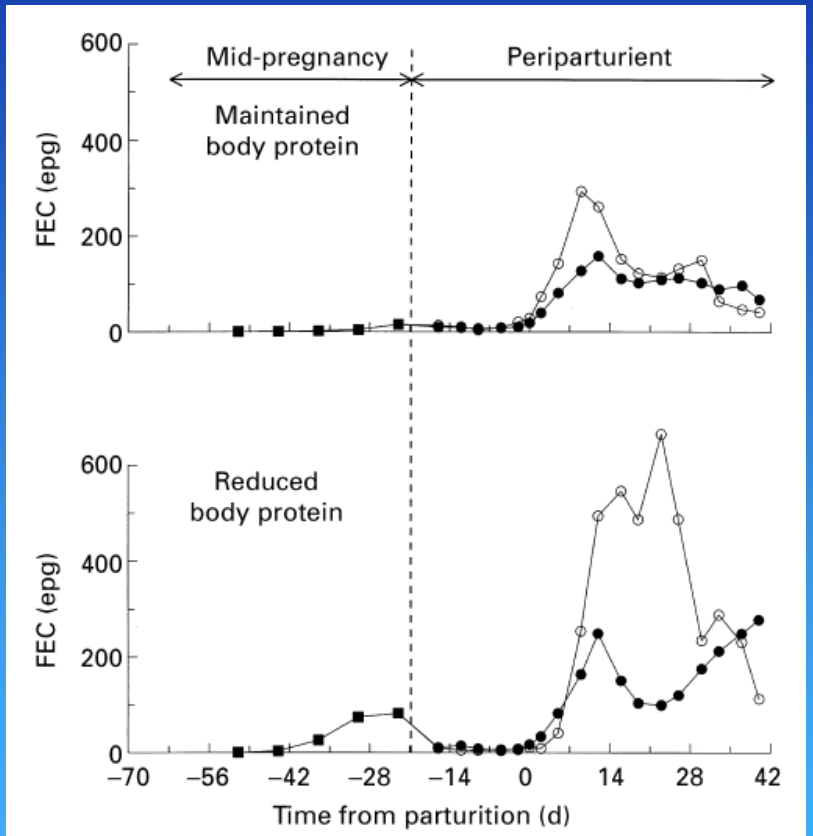


Fig. 2. Backtransformed mean faecal egg count (FEC: expressed as no. of nematode eggs per g faeces (epg)) of twin-bearing and -rearing ewes offered a scarce (○) or adequate (●) amount of metabolisable protein during the periparturient period, following mid-pregnancy feeding strategies to (a) maintain or (b) reduce body protein. The ewes were infected with *Teladorsagia circumcincta* at a rate of 10 000 3rd stage infective larvae for 3 d per week from day –63 onwards. (Redrawn from Houdijk *et al.* 2001*b*.)

Houdijk et al. Proc Nutr Soc 2001

Why would a supplement be needed for a forage-based diet?

Is your forage appropriately balanced for macro-minerals?

Photo from Dr. Joe Rook

Calcium-Phosphorus Balance

Nutrient	Grass Pasture (DM basis)	**Grass Pasture (DM basis)**
Dry matter, %	17.0	**31.6**
Crude protein, %	25.2	**16.6**
ADF, %	31.0	**34.2**
NDF, %	48.6	**56.3**
Ca, %	0.46	**0.26**
P, %	0.59	**0.34**
Mg, %	0.27	**0.29**
K, %	5.04	**2.63**
Fe, ppm	919	**682**
Cu, ppm	11	**11**
Zn, ppm	40	**36**
Flock Problem:	**Hypocalcemia**	**Lamb leg fractures**

Urinary Calculi Risks

Mineral	MMG Pasture			Grass Pasture	MMG Hay	Grass Hay
CP, %	15.3	21.9	20.4	15.6	12.8	10.8
Ca, %	0.32	0.40	0.37	0.27	0.71	0.29
P, %	0.33	0.41	0.40	0.41	0.25	0.54
Mg, %	0.13	0.16	0.16	0.17	0.21	0.25
Na, %	0.004	0.010	0.007	0.007	0.020	0.018
K, %	2.65	3.16	3.11	2.27	1.73	3.26
Cl, %	0.28	0.68	0.45	1.08	0.62	
S, %	0.21	0.27	0.26	0.27	0.21	
Forage samples from camelid farm having urolithiasis problems in male animals						Urolithiasis in Rams

Why would a supplement be needed for a forage-based diet?

Does your mineral supplement balance with your forage?

Photo from Dr. Joe Rook

Forage Mineral Classification

709 forage samples from 23 states

Mineral	Adequate	Marginal	Deficient	High	Cu Antagonists	
Copper	33.3 %	66.0 %	0.7 %	0 %	Mod.	High
Manganese	85.3 %	14.1 %	0.6 %	0 %		
Zinc	23.0 %	43.7 %	33.3 %	0 %		
Selenium	30.2 %	26.1 %	43.4 %	0.3 %		
Sulfur	25.5 %	22.0 %	6.0 %	2.0 %	33.6 %	12.8 %
Iron	70.5 %	0 %	2.8 %	1.7 %	18.6 %	8.0 %
Molyb-denum	51.5 %	0 %	0 %	2.7 %	40.3 %	8.2 %

NAHMS, Mortimer et al., 1999

Forage Mineral Summary

Mineral	Grass Hay		MML Hay		Sheep[1]
Ca, %	0.51	0.28 – 0.75	1.2	0.89 – 1.5	0.2-0.45
P, %	0.24	0.15 – 0.34	0.29	0.23 – 0.34	0.15-0.35
Mg, %	0.21	0.12 – 0.29	0.28	0.21 – 0.34	0.1-0.15
Na, %	0.055	0.0 – 0.173	0.066	0 – 0.169	0.08– 0.15
K, %	1.9	1.23 – 2.52	2.15	1.66 – 2.65	0.5-0.7
Fe, ppm	188	0 – 469	256	0 – 590	30-100
Zn, ppm	26.8	4.3 – 49.3	23.6	8.6 – 38.6	25-50
Cu, ppm	9.2	0 – 19	9.8	0 – 38.3	5-8
Mn, ppm	77.2	13.2 – 141	42.6	13.9 – 71.3	20-40
Mo, ppm	1.05	0 – 2.58	1.35	0 – 2.7	0.5

[1]NRC, 2007 requirements; Maintenance – Lactating
Dairy One Forage Composition Library, 2000-2012

Sheep Copper Deficient?

- Two sheep flocks adjacent to each other
- High lamb losses and 24 of 25 2-year old ewes died on one farm

Liver Mineral Diagnostics

Stillborn Lambs

Test: Nutritional Mineral Screen
Samples: Liver

		429	380	
Calcium	ppm	59.1	169	
Cobalt	ppm	0.013	0.020	
Copper	ppm	14.7	22.2	Low
Iron	ppm	134	80.5	
Magnesium	ppm	121	81.6	
Manganese	ppm	2.71	1.52	
Molybdenum	ppm	0.221	0.039	Normal
Selenium	ppm	0.281	0.295	
Zinc	ppm	11.5	48.7	

All metal results are reported on a tissue wet weight basis.
(cb 02/05/15)

2-year Old Ewes

Test: Nutritional Mineral Screen
Sample: Liver (dried)

Calcium	ppm	248	
Cobalt	ppm	0.304	
Copper	ppm	140	Normal
Iron	ppm	90.8	
Magnesium	ppm	703	
Manganese	ppm	10.6	
Molybdenum	ppm	6.68	High
Selenium	ppm	2.51	
Zinc	ppm	252	

All metal results are reported on a tissue dry weight basis.
AW 04/03/15

No evidence of infectious agents in lambs or ewes. No other significant findings to account for death losses.

Forage Mineral

Problem Farm

Forage	Cu (ppm)	Mo (ppm
Baleage	13	7.81
1st Cut Hay	8.0	3.46
1st Cut Round Bale	7.0	5.66
2nd Cut Round Bale	11.0	7.15
Grain mix	6.0	1.9

Home Farm

Forage	Cu (ppm)	Mo (ppm)
1st Cut Hay	12.0	1.45
2nd Cut Hay	11.0	2.13
Grain mix	7.0	1.62

- Limestone mineral was spread on fields for past two years
- No problems on either farm noticed in older ewes
- Remaining “sick ewes” were brought to home farm and have improved

Postnatal Mineral & Vitamin Status

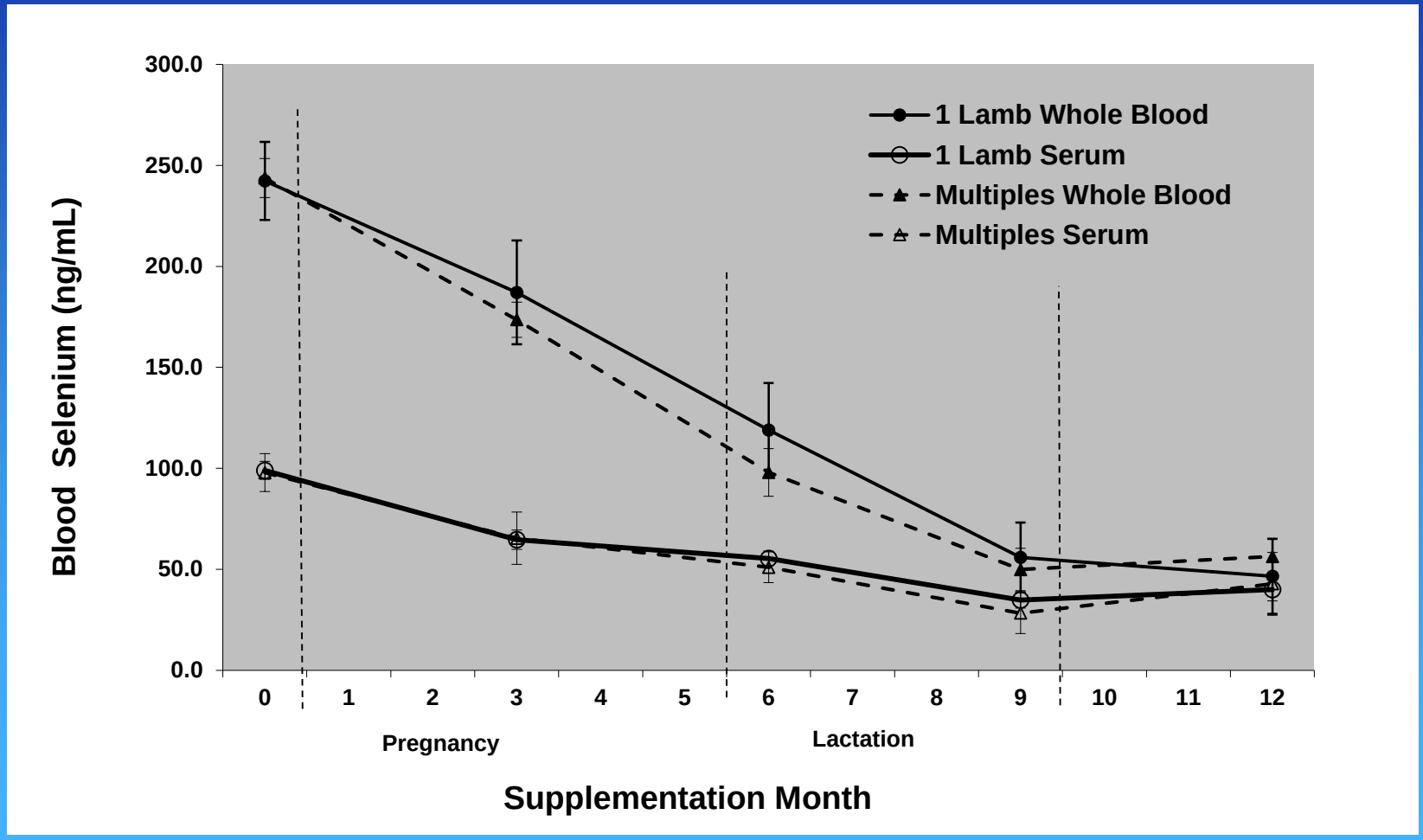
Dependent Upon:

- Placental Transfer
- Colostrum
- Maternal Nutrient Status

Vitamin and Mineral Nutrition

- Macro- and Microminerals
  - All efficiently cross placenta
  - Fetal liver – storage
  - Colostrum – concentrated
- Fat soluble vitamins
  - Do not cross placenta
  - Colostrum – concentrated
  - Physiologic decline around lambing
- Drain on maternal status?
- Adverse effect on immune function?

Selenium Transfer



Hall et al., J Anim Sci 2011

Disease Consequences

- Deficiencies in energy, protein, micro-minerals (Cu, Fe, Se, Zn) and vitamins (A, E) impair immune response
- Lambs with weakened immune response
  - Greater severity and duration of scours
  - More susceptible to pneumonia
  - Fail to build up response to coccidia

Parasites

Nutritional status influences the animal's ability to fight off parasites and be able to adequately survive a mild to moderate infestation.

Dead sheep: diagnosis = Trichostrongylosis

Take Home Points

- Assess forage quality to determine need for any supplement
  - Forage NDF may limit intake
  - Energy and/or protein may be limiting with mature forage
- Forage mineral content is dependent upon species, soil conditions and fertilization
  - Salt should always be available
  - Ca and P supplementation will depend upon forage
- Trace minerals is geographically defined
  - No single product will work for all areas

Questions?