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LIVESTOCK NUTRITION HAY QUALITY AND TESTING

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INTRODUCTION

- Livestock nutrition is about identifying nutrient requirements and feeding to meet those requirements
  - Cattle are ruminants so we are going to try to do that as efficiently as possible with grass and minimal supplementation
    - Economically efficient supplementation
- In order to meet requirements with forage you have to provide a high quality forage and in order to do that you have to understand what is involved in producing high quality forage
- Forage testing is important to know what quality of the forage is and if supplementation is needed to meet the animals requirement so it will be discussed

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WHY IS ADEQUATE NUTRITION IMPORTANT?

- Inadequate nutrition results in:
  - Increased calving difficulty
  - Poorer colostrum quality
  - Reduced reproductive performance
  - Reduced growth rates
  - Reduced carcass quality

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CLASSES OF NUTRIENTS

- Water
- Energy
- Protein
- Minerals
- Vitamins

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WATER

- Requirements vary by:
  - Environment
  - Size
  - Stage of production
- Intake increases with age, weight, and temperature
- Clean water is most important for young calves
- Dirty water reduces performance and is a breeding ground for disease
- Function
  - Helps move feedstuffs through the GI tract
  - Helps flush waste out of the body
  - Temperature regulation
  - Milk production

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Table 11.8 – Approximate total daily water intake of beef cattle (gallons)[a].

	Temperature in °F[b]					
Weight (lbs)	40	50	60	70	80	90
Growing heifers, steers, and bulls						
400	4.0	4.3	5.0	5.8	6.7	9.5
600	5.3	5.8	6.6	7.8	8.9	12.7
800	6.3	6.8	7.9	9.2	10.6	15.0
Finishing cattle						
600	6.0	6.5	7.4	8.7	10.0	14.3
800	7.3	7.9	9.1	10.7	12.3	17.4
1000	8.7	9.4	10.8	12.6	14.5	20.6
Wintering pregnant cows[c]						
900	6.7	7.2	8.3	9.7	-	-
1100	6.0	6.5	7.4	8.7	-	-
Lactating cows[d]						
900	11.4	12.6	14.5	16.9	17.9	16.2
Mature bulls						
1400	8.0	8.6	9.9	11.7	13.4	19.0
1600+	8.7	9.4	10.8	12.6	14.5	20.6

a Adapted from NRC, 2000.
b Water intake of a given class of cattle in a specific management regime is a function of dry matter intake and ambient temperature. Water intake is quite constant up to 40°F.
c Dry matter intake has a major influence on water intake. Heavier cows are assumed to be higher in body condition and to require less dry matter, and thus, less water intake.
d Cows larger than 900 lbs are included in this recommendation.

Beef Cattle Manual, 2008

ENERGY

- Forages
  - High fiber low energy
  - As maturity increase
    - Fiber content measured by neutral detergent fiber increases and quality measured acid detergent fiber increases
    - Leads lower quality lower intake forage
- Grains/byproducts
  - Lower fiber higher energy
    - Starch supplementation should not 0.3% to 0.5% of body weight

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ENERGY

- Fats
  - Most energy dense component
  - 2.25 X energy of Carbohydrates
  - Sources
    - Grains
      - soybeans and corn
    - Animal
      - Byproduct fats
      - Body condition
        - Is used when animals diet cannot meet needs and she goes into negative energy balance
  - Used to produce essential fatty acids which are needed for the production of hormones
    - Growth and reproduction

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MAINTENANCE

- Nutrients required to stay alive
- No productive functions
  - Growth
  - Lactation
  - Pregnancy
- NE_m = 0.077 Mcal * (EBW kg) $^{0.75}$

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FACTORS AFFECTING ENERGY REQUIREMENTS – BREEDING CATTLE

- Body Weight
- Stage of Production
  - Dry vs. Lactating
  - Heifers vs. Cows
- Milk Production
- Environment
- Genetics

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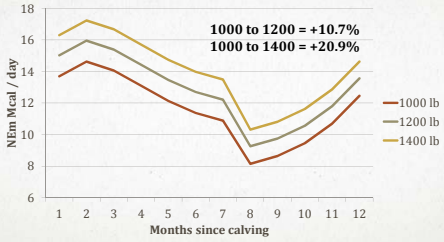
EFFECT OF BODY WEIGHT ON MAINTENANCE ENERGY REQUIREMENT



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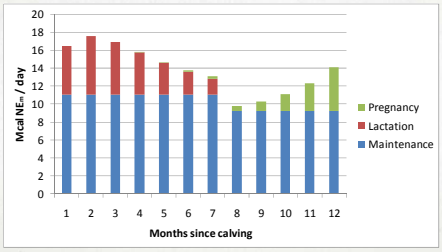
1300 POUND COW ENERGY REQUIREMENTS



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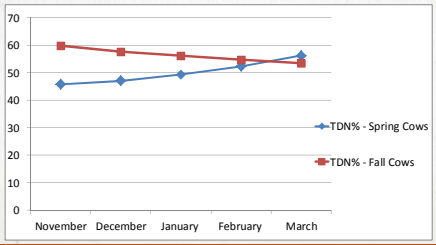
WINTER ENERGY (TDN) NEEDS FOR BEEF COWS



Adapted from: NRC, 1996

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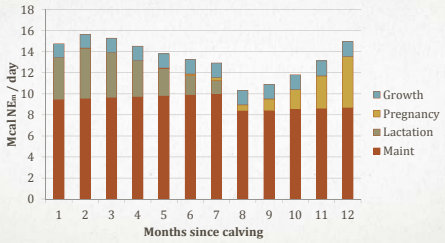
1ST CALF HEIFER ENERGY REQUIREMENTS



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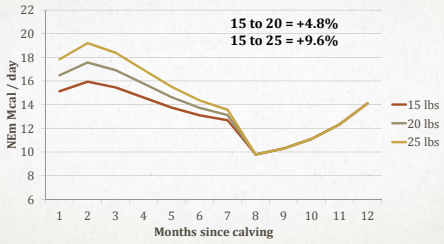
EFFECT OF LACTATION ON ENERGY REQUIREMENT



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EFFECT OF COLD STRESS

- For each 1º below the critical temperature a cow's energy requirement goes up 1%
- Protein Requirement DOES NOT CHANGE

Table 1. Estimated Lower Critical Temperatures for Beef Cattle *

Coat Description	Critical Temperature
Summer Coat or Wet	60 degrees F
Dry Fall Coat	45 degrees F
Dry Winter Coat	32 degrees F
Dry Heavy Winter Coat	19 degrees F

* From Browsen, R. & Ames D."Winter Stress in Beef Cattle" Cattle Producer's Library. CL760.

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GENETIC ROLE IN MAINTENANCE

Type / Breed	Maintenance Multiplier
English / Angus, Hereford	1
Dairy / Holstein, Jersey	1.2
Continental	
Limousin, Charolais, Chianina	1.0
Gelbvieh	1.1
Simmental, Braunvieh	1.2
Bos indicus	
Brangus	0.95
Brahman	0.90

NRC, 2000

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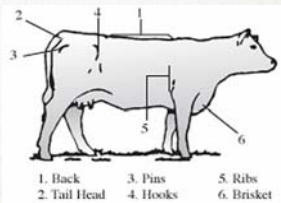
BODY CONDITION SCORING

- BCS Scoring
  - On a 1-9 scale
  - Looks at fat deposition at key points on the body
    - Ribs and backbone
    - Tail, hooks and pins
    - Brisket



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BODY CONDITION SCORING

Photo 4: BCS 4. Borderline condition. Outline of spine slightly visible. Outline of 3 to 5 ribs visible. Some fat over ribs and hips.

Photo 5: BCS 5. Moderate, good overall appearance. Outline of spine no longer visible. Outline of 1-2 ribs visible. Fat over hips but still visible.

Photo 6: BCS 6. High moderate condition. Ribs and spine no longer visible. Pressure applied to feel bone structure. Some fat in brisket and flanks.

Virginia Cooperative Extension Publication 400-795

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BODY CONDITION SCORING

Photo 7: BCS 7. Good, fleshy appearance. Hips slightly visible but ribs and spine not visible. Fat in brisket and flanks with slight udder and tail head fat.

- Optimal body condition score is between 5 and 7
- Evaluate 60 to 90 days prior to calving to determine feeding protocol to maintain or improve BCS
  - Condition prior to calving of 6
  - Condition at breeding is 5
  - Wean at condition 4
- Thin Body Condition problems (BCS 1 – 4)
  - Failure to cycle
  - Failure to conceive
  - Increased calving interval
  - Increase days to estrus
  - Decrease calf vigor

Virginia Cooperative Extension Publication 400-795

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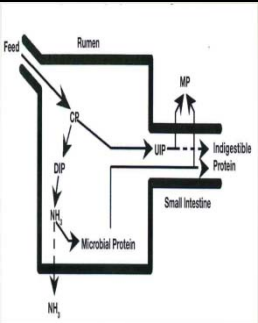
LIVESTOCK NUTRITION

- Protein type
  - Crude Protein: N*6.25
  - Undegradable intake protein: Protein that bypasses the rumen
  - Degradable intake protein: Protein degraded in the rumen
  - Microbial Protein: Protein produced in the rumen
  - Metabolizable protein
    - Protein used by the animal
  - Indigestible protein
    - Protein loss in feces



Beef Cattle Manual, 2008

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PROTEIN

- Natural versus non protein nitrogen
  - Natural proteins are from hay, grain and plant based proteins
    - Combination of DIP and UIP
  - Non protein nitrogen is sources like urea and is totally DIP
    - Utilized in high grain rations such as feedlot rations
- Requirements vary by
  - Age
  - Stage of production
  - Growth rate
- Rumen bugs require protein and if the total diet is below 7% crude protein this will negatively affect the bugs and reduce intake and negatively affect performance

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PROTEIN

- A lack of protein is usually not the biggest problem we have with cool season grass/legume pasture and hay
- Supplementing protein, in most cases is costly, especially in convenient forms like tubs or protein blocks
  - by – product supplements like distillers grains, corn gluten feed, and brewers dried grains
  - Alfalfa hay

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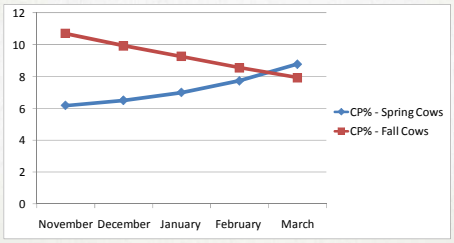
WINTER PROTEIN NEEDS FOR BEEF COWS



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FECAL CONSISTENCY

14.8% CP
28.2% fiber
53.2 % TDN
Low fiber
Easily digested

5.1 % CP
31.5% fiber
53.7% TDN
Very low protein
decreased digestibility

8.8% CP
32.8% Fiber
46.3% TDN
Low energy

Dr. Tom Troxel
University of Arkansas

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MINERALS

- Small portion of feed intake but very important
- Large part of bone, muscles, organs, cells and enzymes
  - Structure
  - Production
- Mineral deficiency can lead to poor performance and health issues
- Split into 2 categories
  - Macro minerals
  - Micro minerals

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MACRO MINERALS

Mineral	Most significant known functions in the body	Source
Calcium (Ca)	Bone & teeth formation, nerve & muscle function	Forages
Phosphorus (P)	Reproduction, health of bones & teeth	Grains
Magnesium (Mg)	Growth, reproduction, metabolic functions	Mineral supplement, legumes
Potassium (K)	Metabolic functions	Forages
Sulfur (S)	Metabolic functions, amino acid formation in rumen	Forages & grains

Mineral Nutrition of Beef Cattle; University of Tennessee PB 1749

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SUGGESTED SUPPLEMENTAL MACRO MINERAL LEVELS

Nutrient	Mature	High Mag	Growing
Salt, %	25	25	25
Calcium, %	12	10	10
Phosphorus, %	6	6	6
Magnesium, %	2	10	1
Potassium, %	0.5	-	0.5

2-4 oz / head / day intake

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MACRO MINERALS

- Calcium/Phosphorus
  - 2:1 ratio
  - Phosphorus supplementation
    - Forage phosphorus levels less than the following require supplementation
      - 0.18% dry cow
      - 0.27% lactating cow
      - 0.27% growing calf
  - Feeding 3 lbs of DDGS is equal to 4 oz of 10% phosphorus mineral
    - If you are feeding distillers grains may need to add calcium to balance ratio

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MACRO MINERALS

- Calcium/Phosphorus
  - P concentration is greater when
    - Plant is vegetative
    - Animals can selectively graze
  - Consider P supplements when
    - Low soil fertility
    - Drought stress
    - Frosted forage

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MACRO MINERALS

- Magnesium Supplementation
  - Grass tetany caused by
    - Excessive K in lush forage
    - Difficulty mobilizing bone Mg
    - Excessive non-protein nitrogen supplements
    - Low calcium intake
  - Provide High – Mg mineral 30 days prior to green up

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MACRO MINERALS

- Potassium supplementation
  - Weathered forages are low in K
  - Utilize a 0.5 to 0.8% K mineral to supplement forages
  - Remove K supplementation during early spring through fall

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TRACE OR MICRO MINERALS

Mineral	Most significant known functions in body	Source
Chromium (Cr)	Immune response, glucose tolerance factor	Cereal grains
Cobalt (Co)	Component of Vitamin B12	Legumes
Copper (Cu)	Hemoglobin formation, tissue metabolism	Forages & grains
Iodine (I)	Thyroid hormones, energy metabolism	Forages
Manganese (Mn)	Reproduction enzyme formation	Forages
Molybdenum	Enzyme activity	Forages
Selenium	Antioxidant, glutathione peroxidase	Grains & forages
Zinc	Enzyme activity	Legumes

Mineral Nutrition of Beef Cattle; University of Tennessee PB 1749

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SUGGESTED SUPPLEMENTAL TRACE MINERAL LEVELS

Nutrient	Mature	High Mg	Growing
Copper, ppm	1500	1000	1000
Manganese, ppm	3000	2000	2000
Zinc, ppm	3500	3000	3000
Iodine, ppm	60	50	50
Cobalt, ppm	12	10	10
Selenium, ppm	12	10	10

2-4 oz / head / day intake

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VITAMIN SUPPLEMENTATION

- Vitamin
  - A – Green, growing forage
  - D – Sun and skin conversion
  - E – Green, growing forage
- Supplement dormant or weathered forages

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SUGGESTED SUPPLEMENTAL VITAMIN LEVEL

	Cows, IU / lb	Calves, IU / lb
Vitamin A	250,000	125,000
Vitamin D	25,000	12,500
Vitamin E	100	100

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NUTRITION SUMMARY

- Identify nutrient requirements
  - They vary so pick the correct one for the cattle you are feeding
- Test feedstuffs to determine nutritive value
- Feed according to requirements and economically efficiently as possible
  - Separate animals based on requirements and feed accordingly
  - Supplement when needed but make it economically feasible
- Be aware of mineral deficiencies and take steps to prevent these problems

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PERTINENT TOPICS

- Why should I sample hay?
- How should I sample hay?
- How do I read these results?
- What am I supposed to do with them?

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ALL HAY IS NOT EQUAL

- Cannot visually determine forage quality
- Variation due to:
  - Forage maturity
  - Forage species
  - Fertilization program
  - Weather conditions
  - Hay making losses
  - Storage losses

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HOW TO SAMPLE HAY

- Use a probe
- Sample ~20 bales from each lot of hay
- Thoroughly mix the samples in a plastic bucket
- Subsample, put in plastic bag and send to the lab

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FORAGE TESTING TECHNIQUES, LABS, AND COSTS

- Chemical analysis
  - Generally more expensive
  - Takes more time
  - More accurate (?) esp. w/ unusual feeds
- NIRS
  - Quick & inexpensive
  - Accurate for common nutrients / feeds
- Websites
  - http://agebb.missouri.edu/beef/grazing/index.htm
  - http://www.foragetesting.org/index.php?page=certified_labs
  - http://www.extension.iastate.edu/dubuque/sites/www.extension.iastate.edu/files/dubuque/foragetestinglabs.pdf

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LAB ANALYSIS

- Measured Components
  - Acid Detergent Fiber (ADF)
    - =Digestibility
    - = cellulose & lignin
  - Neutral Detergent Fiber (NDF)
    - =Intake
    - = total cell walls
    - = cellulose, lignin & hemicellulose
  - Ether Extract, fat
  - Nitrogen
  - Minerals
  - Antiquality
- Calculated Components
  - Net Energy (NE)
    - calculated from ADF
  - Total Digestible Nutrients (TDN)
    - calculated from ADF
  - Digestible Dry Matter (DDM)
    - calculated from ADF
  - Dry Matter Intake (DMI)
    - calculated from NDF
  - Relative Feed Value (RFV)
    - calculated from NDF & ADF
  - Relative Forage Quality (RFQ)
  - Crude Protein (CP)
    - calculated from Nitrogen

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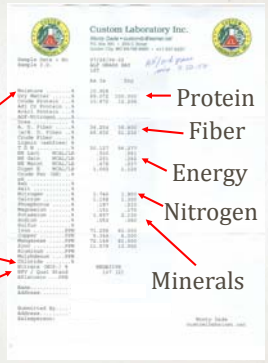
How do I read the results?



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MATURITY INFLUENCES QUALITY

Forage Crop	Stage of maturity	NDF%	TDN%	CP%
Alfalfa	Early Vegetative	33	66	30
	Early Bloom	39.30	60	25
	Mid Bloom	47.10	58	22
	Full Bloom	48.80	55	17
	Late Bloom	53.00	53	17
	Mature	58.00	50	14

Beef Cattle NRC, 2000

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MATURITY INFLUENCES PERFORMANCE

Effects of stage of maturity of alfalfa hay at harvest on gains of yearling steers			
Stage of Maturity	ADG (lbs./d)	Total Gain per steer (lbs.)	Feed/100 lbs. of gain
Bud	1.07	96	959
1/10 bloom	0.76	69	1,351
Full Bloom	0.63	58	1,600
Seed	0.48	44	2,144

Feeds and Nutrition, 1990

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FORAGE MATURITY IMPACTS FORAGE QUALITY AND FEEDING VALUE

- As forages mature:
  - Yield increases
  - % stems increases
  - % ADF and NDF increase
  - % Lignin increases

Increasing yield does not necessarily increase the amount of animal available nutrients being harvested.

- As forages mature:
  - % leaves decrease
  - % protein decreases
  - Energy value decreases
  - Digestibility decreases
  - Intake decreases
  - Production / animal decreases

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SPECIES EFFECT ON FORAGE QUALITY

Nutritive values of different full bloom hays				
Feed stuff	NDF (%)	TDN (%)	ME (Mcal/kg)	CP (%)
Fescue K31	67	58	2.10	12.90
Alfalfa	48.80	55	1.99	17.00
Red Clover	46.90	55	1.99	15.00
Timothy	64.20	56	2.02	8.10

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DAMAGES EFFECT ON FORAGE QUALITY

Effects of Rain damage on Red Clover Hay				
	Good Drying conditions		Poor Dry Conditions	
	No Rain	Rain	No	Rain
Harvesting stage			% CP	
Late bud to first flower	22.4	22.1	23.8	26.5
Full to late bloom	15.0	14.9	15.4	14.9
			% DMD (% IVDMD)	
Late bud to first flower	75	72	68	47
Full to late bloom	67	63	62	49
			% NDF	
Late bud to first flower	31	37	30	44
Full to late bloom	42	45	40	55

Feeds and Nutrition, 1990

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COMPARING HAY TEST RESULTS 1,300 LB. COW, MID-GESTATION, MAINTENANCE

- **2004 – 2015 mean of sample <u>average</u> values**
  - **CP% = 10.0**
  - **TDN % = 53.6**
  - **NEm, mcal/lb = 0.48**
- **100% DMI Hay provides:**
  - **100% NEm**
  - **95 % Metab. Protein**

- **2004 – 2015 mean of sample <u>minimum</u> values**
  - **CP% = 6.0**
  - **TDN % = 45.7**
  - **NEm, mcal/lb = .36**
- **100% DMI Hay provides:**
  - **75% NEm**
  - **66% Metab. Protein**

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HAY TEST COMPARISON MAY HAY VS. JULY HAY

	May Fescue Hay	July Fescue Hay
CP, %	12.3	7.8
ADF, %	39.9	43.3
TDN, %	60.3	55.1
NEm, mcal/lb	0.55	0.47

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HAY TEST TO RATIONS MAY HAY

	BCS 4 + ½ BCS / mo.	BCS 4 + ¼ BCS / mo.	BCS 5 Maint.
NEm Mcal requirement*	15.5	13.4	11.8
NEm, % of req.@ 100% hay	93	108	122
Met. CP, % of req. @ 100% hay	80	95	118
Supplement	1.3 lb. DDG	-----	-----
* = 1,300 lb. cow, mid-gestation			

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HAY TEST TO RATIONS JULY HAY

	BCS 4 + ½ BCS / mo.	BCS 4 + ¼ BCS / mo.	BCS 5 Maint.
NEm Mcal requirement*	15.5	13.4	11.8
NEm, % of req.@ 100% hay	77	89	101
Met. CP, % of req. @ 100% hay	70	84	104
Supplement	Corn 4 lbs. + DDG 2 lbs.	Corn 2.5 lbs. Or DDG 2.5 lbs.	-----
* = 1,300 lb. cow, mid-gestation			

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HAY TEST COMPARISON STAGE OF PRODUCTION

	Mid gest. May hay	Mid gest. July hay	Late gest. May hay	Late gest. July hay
NEm, Mcal requirement*	11.8	11.8	13.7	13.7
NEm, % of req.@ 100% hay	122	101	104	87
Met. CP, % of req. @ 100% hay	118	104	99	87
Supplement	-----	-----	-----	3.5 lbs. corn
* = 1,300 lb. cow, BCS 5, maintenance				

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SUPPLEMENT OPTIONS

- By product feeds
  - Both energy and protein
    - Distiller's grains, corn gluten feed
  - Energy
    - Soybean hulls
- Grain
  - Provide energy and limited protein
- Protein
  - By-products
  - High quality forage
  - Cubes, tubs, liquids

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OTHER CONSIDERATIONS

- Palatability
  - Mold
  - Weeds
- Excessive storage losses
  - Unprotected, ground storage
  - Excessive heating due to high moisture at baling
- Fescue Problems
  - Toxic endophyte
- Insect Damage

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CONCLUSION

- Nutritive value varies between hays and other feedstuffs
- Animal requirements vary
- For Optimum performance
  - Test feed stuffs
  - Formulate ration to meet animal requirements
  - Evaluate your animals performance
    - Monitor body condition score
    - Calf performance and growth
    - Cow reproductive performance
    - Fecal consistency

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CONCLUSION

- If performance is lacking supplement as economical efficient as possible
- Cows that maintain condition better will require less supplementation
  - Consider culling cows that do not maintain condition well
- Baling high quality hay will reduce the amount of supplementations

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QUESTIONS

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